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THE POSTMASTER-GENERAL AND POST OFFICE MEETINGS.

IN connection with the discussion of the Post Office estimates, an interesting debate was opened up last week in the House of Commons, when a matter largely affecting the liberty of action of all sections of public officials coming under the control of the Postmaster-General was submitted to severe criticism.

Some time ago the Postmaster-General issued, what were termed, new regulations, under which those engaged in the departments under his control might hold public meetings—these regulations were spoken of as being a relaxation of an official order dated 1866.

From the surprise evinced publicly and officially at the discovery of this comparatively ancient document, and its subsequent amendment by the Postmaster-General, there can be but little doubt that thousands of those directly interested had never heard, or even dreamt of, such a regulation. The heads of departments, too, were in precisely the same state of happy ignorance, and the intelligent being who succeeded in resurrecting the almost unknown order of 1866 from some dusty, neglected, and probably all but forgotten official sarcophagus, will feel that he, at all events, deserves well of his Queen and his country.

The obsoleteness of this practically unused tool was too palpable, however, to even a Postmaster-General, and though it was put before the Post Office departments in a sort of "this is what it could be" style, the amended order was adopted as the standard by which all future "staff" meetings would be gauged.

We have referred to the order of 1866 as practically unused. No instance has been quoted in which its application has been resorted to. The Postmaster-General, indeed, confessed that, to his surprise, its existence had been ignored; but we go further than this, and say its existence was unknown; and previous events prove this to be true. It cannot be said that it could not have been used in the past twenty years, for there have been several movements in various grades of the Postal Service, notably, amongst postmen, sorters, sorting clerks, telegraph clerks, and savings bank clerks, and these movements, at all events, extended to as far back as 1872. In 1881 a strong agitation, fully justified by results, and which made its existence felt throughout the country, occurred in the telegraph service. Prof. Fawcett, the Postmaster-General at that time, did not restrict in any way a movement which, we believe we are correct in saying, he regarded, and even spoke of, as constitutional. Whatever was thought of the progress of the events by the higher departmental officials at that time, and, in some instances, their hostility was not disguised, it is a matter beyond dispute that free public meetings were not only general, but recognised as the legitimate channel for gaining public attention, and most people will fail to see why this should not be the case now. In 1881, the order of 1866 was conspicuous by its absence; and even if it still lingered in the minds of a few, which we doubt, it was looked on as obsolete and old-fashioned. Though the Postmaster-General holds strongly that he has acted in an equitable spirit to those under him, still, the questionable advantages conferred by what will be regarded by many as a fair specimen of official tinkering, do not seem to have won the hearts of those who are inclined to go into the subject, and few will be surprised at their non-conversion. At such meetings in future no one is to be present save those in the service—whatever their status may be. This seems to be specially aimed at those public men whose presence is so often a tower of strength to causes in which many of those interested expect and seek an outside stimulus. But this restriction is double edged. If it deprives one side of friends and councillors it does the same to the other. Will the Postmaster-General say, for instance, that the presence of two or three earnest and moderate members of Parliament, or even other public men, at some of the recent meetings in connection with the mismanaged postmens' movement would not have averted the unfortunate catastrophe which unwise and hasty action engendered? Would not their in-

fluence have held in check, for example, what has been aggressive and suicidal zeal on the part of an individual, or individuals, at the head of the Postmen's Union?

The telegraph clerks' movement, too, may afford another case in point. After conducting a series of meetings in 1889, some with the aid of members of Parliament whose moderate and rational councils have always prevailed, and some without, nothing being kept from the public Press, which is surely a reliable medium of information and discussion, they, too, were brought under the provisions of the Postmaster-General's amended order.

To them assuredly the position was most unpleasant, especially after their unfettered experiences of 1881, and it may have been felt that the Postmaster-General's regulations were more irksome than he had any intention of making them.

There can be no doubt that in many quarters this restriction is considered harsh and arbitrary, and though the Postmaster-General repudiates all such intentions we cannot say that, even with the majority of the House of Commons on his side, he has made out a good case; on the contrary, we question the wisdom and expediency of his action.

The Postmaster-General also requires a statement of the business to be discussed at public meetings, and sends an official reporter to take verbatim reports of all speeches and the names of the speakers. A number of meetings have been held under these conditions, and the Postmaster-General professes to be satisfied with the results of his innovation. His satisfaction, we imagine, is scarcely shared by his subordinates.

To a few meetings, indeed, he has not deemed it necessary to send the "official reporter," and the absence of this doubtful advantage has not led to anything more startling than an expression of surprise that the Postmaster-General should have broken his own rule.

The Postmaster-General also urges that he requires true accounts of what is said, so that grievances and complaints of all kinds may be thoroughly understood and properly considered. He may attain these ends by his plan, but we have heard from not a few in various departments that they would be delighted to have the Postmaster-General in person at their meetings, though they object naturally enough to the "official reporter."

This ingenious if not ingenuous explanation would lead many people to imagine that such a thing as a free public press had no existence in these islands, or if it did exist, that its power as an advocate and mediator was practically inert. Happily, its power needs no demonstrating. It is mighty in its fearless trinity of advocation, mediation, and criticism.

It must be palpable to everyone that in the hands of officials antagonistic to public meetings, public discussion, and public sympathy, the Postmaster-General's regulations are capable of being used in a most despotic and tyrannical manner, under which officialism would become invested with an aggressive as well as a repressive power, a menace to the one side and a danger to the other. Public opinion would remedy these matters, but this might not be done until individuals had suffered.

On the other hand, under a generous observance of, and a fair adherence to, those constitutional principles which the Postmaster-General has expressed himself so anxious to encourage, little if any sense of a loss of constitutional right would be felt by those who had substantial and practical questions to ventilate.

Nevertheless, the era of such Draconian rules has certainly passed away, and, under the circumstances, many will regret that the order of 1866 was not relegated for ever to that official obscurity under which it had enjoyed the advantages of nearly a quarter of a century's rest and peace, its bare existence apparently unsuspected by quite a number of Her Majesty's Postmasters-General.

Fire Rules and Regulations.

WE are sadly in want of a set of standard rules for fire risks which would prove acceptable both to insurance offices and electrical contractors. As neither the Phœnix rules nor those compiled by the Institution of Electrical Engineers satisfy the requirements, much uncertainty and considerable annoyance, to contractors particularly, result. Not long since a firm of electrical engineers notified to a fire office that a certain installation was about to be fitted up, and a request was also made for the office to inspect, if it was thought desirable, insurance being effected also with another company. In reply, a letter was received from the inspector, asking for particulars, samples of leads, and enquiring whether the work was being carried out in accordance with the rules of his office. The contractors sent the conductor specimens, and an intimation that the installation had been carried out in the usual manner. They did not wish to commit themselves to any given rules, lest anything occurred afterwards by which they, through a technical objection easily raised on behalf of the fire office, might be held liable. The next episode in this little comedy of errors was the receipt of a letter by the contractors which their own client had received from the fire-office. To their surprise the document commenced by informing the recipient that in consequence of the numerous fires from electricity that have occurred, and the liability of electricity to suddenly cause fire without the least warning in any part of the house where the conductors run, it would be readily understood that the fire office was particularly desirous of ascertaining what precautions had been adopted against danger. Moreover, it was stated that the only reason for troubling the gentleman to whom it was addressed was because the contractors had refused to give any information as to the manner in which the installation was carried out, an assertion which, on the face of the correspondence was, to put it mildly, a perversion of the truth. What the upshot of the business is we do not know, but the incident shows clearly that there is considerable friction between fire offices and contractors, and the sooner they can transact their mutual affairs on a basis suitable to both so much the better for the consumers of electrical energy, who do not desire to be troubled with the quarrels of those whom they engage to supply them. Furthermore, when a fire office asserts that there have been numerous fires from the use of the electric light, and that there is a liability to this

danger at any time and without warning, it becomes desirable in the public interest that these facts should be known without delay. Captain Shaw recently reported that the fires in London from electric lighting amounted to three only during the years 1888 and 1889. Either he is right and the fire office wrong, or there must have been many conflagrations from this cause in the provinces, of which we have never heard. However this may be, we think electrical contractors might with advantage agitate for a set of rules which would enable them to carry out their work on some tangible basis, and steer them clear of the whims or caprices of inspectors, who are too often in antagonism with each other's regulations.

Gas Works and Electric Lighting.

IN the REVIEW for July 11th we published an abstract of a paper, read by Mr. Arthur F. Guy, entitled "Shall Gas Undertakings supply Electricity? Yes." Mr. Guy, who seems to be a very young man, and was probably carried away by the enthusiasm of youth, argued that gas companies were favourably situated in all respects for undertaking the supply of electrical energy; but a perusal of the remarks made by Mr. Stewart, the President of the North British Association of Gas Managers, entirely dissipates this idea. That the latter gives the correct view of the situation is certain, but it would be interesting to our readers to see how Mr. Guy proposes to combat the matured reasoning of his more experienced antagonist.

Improvements in Arc Lamps.

IN our issue of March 14th we commented somewhat strongly on the highly-coloured statements which had come before our notice respecting the immense advantage of introducing a hydro-carbon vapour into the electric arc. We freely admitted that the light would be increased, but we doubted the practicability of the methods adopted to regulate the supply of hydro-carbon. Moreover, so far as the principle of the invention was concerned, we showed clearly enough that it was of many years standing. Our views were perfectly correct as the mechanism of the lamp then stood, but since that period Mr. Apps, the well-known scientific instrument maker, who has been indefatigably introducing improvements in rapid succession in the Saunderson arc lamp, appears to have overcome what then proved serious obstacles to its practical operation, in an entirely successful manner. The method of producing the extremely small supply of vapour necessary has now been reduced to a matter of the greatest simplicity, and credit is due to the inventor who gave Mr. Apps *carte blanche* to proceed as he pleased for the pertinacity with which he has stood to his guns in the face of innumerable difficulties. Accompanied by Mr. Apps a few nights since, we wended our way to a metropolitan railway station, where a Brockie-Pell lamp, fitted with Saunderson's carbons, had been for some weeks regularly working in series with a number of Brush arcs. Naturally, in the absence of proper apparatus, we were unable to compile any definite photometric data; but by roughly measured shadow tests and other simple means, we had little difficulty in perceiving that the light was much superior to that given by each of the others—at least half as much again. The cost of producing this extra luminosity, Mr. Apps informed us, does not exceed 6 per cent. on the price of ordinary carbons, and it is proposed to supply the hollow carbons with the hydro-carbon attachment, which are made to suit any lamp, to the trade generally, on the basis of a very small royalty on the market price. This is a wise course to pursue, and doubtless Mr. Saunderson will reap much more benefit from universally dealing with lamp makers than by the course of promoting a company to exploit and introduce his invention as an improved lamp, such as at one time seemed probable. His greatest sphere of operations, we imagine, will be found in America and in certain continental countries, for the development of arc lighting here is slow and tedious in the extreme.

State Control and Telephony.

OUR friend, the *Electrician*, is, to put it mildly, a trifle shaky in its political economy. Having advocated in the strongest terms the purchase of the telephones by the State, Mr. H. W. Fawcus has written, putting the truth before our contemporary in language pretty similar to what we used in our leading article a fortnight since. The *Electrician* now declares itself utterly opposed to Socialism, but qualifies the declaration with the remark that the position of the Post Office is no more one of State Socialism than is the War Office. Whether the monopoly of letter carrying and telegraphing by the State is justifiable need not be here considered, but there is no doubt that its existence illustrates a distinct phase of Socialism, while the position of the War Office is a very different matter. It is the function of the State to protect the citizens from foes abroad and friends at home if need be, to dispense justice and enforce rights between man and man, thus maintaining a condition of things under which individual enterprise may develop and secure its due reward. The War Office undertakes to deal with the foreign foe, but it is scarcely necessary that for the protection of individual interests at home the State should carry the citizens' letters, deliver their telegrams, or keep telephonic bureaus open. In fact, our contemporary fails like a good many others to distinguish between what the State ought to do and what it should let alone, between the duties for the performance of which it exists and the affairs with which it has no business. Though the *Electrician* declares loudly enough for "no Socialism," due to that extraordinary obliquity of vision which distorts political views generally, it sees nothing subversive of its principles in a letter-carrying monopoly, in State controlled telegraphy, in Government subsidies to newspapers, or in officially managed telephony. The principle of Individualism is approved, and as that of Socialism has been disavowed, it becomes convenient to call schemes essentially socialistic in their character and scope, by another name. So our contemporary regards the supply of electricity as a commercial undertaking, but the supply of telephonic facilities as a State affair. Given a political creed, it is always easy to find excuse for an infraction of its tenets should such infraction be thought for the time expedient.

License to the Mutual Telephone Company.

REFERRING to the projected telephonic competition at Manchester, our contemporary, in the same article to which we refer above, says:—"For our part we cannot help thinking that one of its first and chiefest difficulties will be to obtain the licence of the Postmaster-General." Would it surprise our contemporary to know that the license is already granted?

EXPERIMENTAL PROOF OF HELMHOLTZ'S RELATION.

THE difference between the chemical and the electrical energy of a cell is equivalent to the product of the absolute temperature with the change in the difference of potential, with the change of temperature, or, in other words, with the temperature coefficient of the cell. This is the theory enunciated by Helmholtz some time ago. According to this hypothesis, if the chemical energy of any given cell is greater than its electrical energy, the temperature coefficient is negative ; whilst, on the other hand, if the electrical energy of the cell is greater than its chemical energy, the temperature coefficient is positive.

It is evident, on considering this theory, that if the temperature coefficient can be ascertained, it may at once be determined whether the chemical energy of the cell is only partially converted into electrical energy or whether the electrical energy of the cell is in excess of its chemical energy.

Experiments to prove Helmholtz's relation between the secondary heat of a galvanic element and its temperature coefficient were undertaken a short time ago by H. Jahn, who afterwards published his results in a paper which may be read in Poggendorf's *Annalen der Physik und Chemie*, Series II, Vol. xxviii., page 491.

The cells examined by Jahn were silver and silver nitrate with lead and lead nitrate, and with copper and copper nitrate respectively. The solutions were made up to a strength represented by the following formula :—

$$(M')_2 (NO_3)_2 + 100\ H_2O$$

when M′ stands for the metal employed. NO_3 for the "nitrate" part of the salt, and H_2O for water.

Jahn was successful in obtaining a number of exceedingly interesting results, of which we may briefly allude to certain that are typical.

The chemical heat of a galvanic element is obtained from the formula—

$$Q = W - a\,J\,(\triangle - J\,\sigma)\,t$$

in which the letters have the following significance.

W = The heat evolved in the cell.
a = The heat equivalent of unit of work.
J = The current intensity in ampères.
$\triangle - J\sigma$ = The difference of potential of the electrodes.
t = The duration of the experiment.

The value obtained from this formula for Q, the chemical heat of the galvanic element, agree closely with those obtained from thermo-chemical data.

If Q′ stand for the current heat and S for the secondary heat, then the secondary heat is given by the equation—

$$S = Q - Q'$$

that is to say, the chemical heat, less the current heat, gives the secondary heat which is compared with that obtained by calculation from Helmholtz's relation.

Here are some specimens which illustrate this and at the same time show the accuracy of Jahn's experimental work :—

ELEMENTS.

Results.	A: Ag_2, $Ag_2(NO_3)_2$ $Pb(NO_3)_2$, Pb.
E.M.F.	= 0·932
Chemical heat	= 50·870
Current heat	= 42·980
Secondary Heat { Found ...	= 7·950
Secondary Heat { Calculated ...	= 7·890

Results.	B: Ag_2, $Ag_2(NO_3)_2$ $Cu(NO_3)_2$, Cu.
E.M.F.	= 0·458
Chemical heat	= 30·040
Current heat	= 21·120
Secondary Heat { Found ...	= 8·920
Secondary Heat { Calulated ...	= 8·920

These investigations into the equivalence of chemical energy and current energy have been supplemented quite recently by F. Streintz who has contributed an excellent paper to Poggendorf's *Annalen der Physik und Chemie*, Series II., Vol. xxxviii., p. 514.

In this paper he discusses Helmholtz's theory, and gives the results of an elaborate series of experiments undertaken by himself, and especially calls attention to his experiments with a silver-mercury cell and its relation to temperature.

Streintz observed some time ago that a cell composed of the following elements—

$$Ag \mid Ag_2SO_4 \mid H_2SO_4 \mid H_2$$

has an electromotive difference of potential of zero at the ordinary temperature. This was not explained at the time, but he now finds that the phenomenon is due to the fact that a change from positive to negative takes place here in the temperature coefficient, and that this change takes place at a certain temperature, T_0, at which the difference of potential, p_0, is equal to zero.

Hence it follows that if a silver mercury cell be plunged into ice-cold water, the silver forms the positive pole, whereas when the element is transferred to hot water, the mercury forms the positive pole, and the silver becomes negative.

Streintz has used this interesting cell in testing the theory of Helmholtz, which is briefly enunciated at the commencement of this paper, and he finds that there is a perfect agreement between the theoretical deductions of Helmholtz and his own experimental results. For the numerical data we must refer our readers to the original paper.

THE ELECTRIC LIGHT AT BOMBAY.

[FROM A CORRESPONDENT.]

THE late Municipal Commissioner of Bombay last year advertised for tenders for the electric lighting of the city. These advertisements appeared in the two Bombay dailies, in some of the leading English papers, and in some American journals. Five tenders were sent in, particulars of which have been inserted in the Bombay papers.

The first of these was from Siemens Brothers, of Berlin. This company offered to erect and supply for £40,000 a complete generating plant and system of underground leads adapted for 5,000 glow lamps, 16 candle-power, but excluding cost of opening up streets, house, and street lamp connections.

Crompton & Co. proposed two alternative schemes for arc and glow lights respectively. The former plan would comprise 41 arc lamps of 2,000 candle-power, at 80 yards apart, the machinery in duplicate, but the site and machine house to be supplied by the municipality. Their prices are stated in such a manner as not to be easily comparable with the tender of Siemens Brothers and Co.

Laing, Wharton and Down propose an arc light system, including 33 lights for the road from the Apollo Bunder to the Crawford Markets and 20 in the markets. The lights are to be each of 2,000 candle-power, and to be charged for at the rate of £32 a lamp annually for two years, £30 if for three years, and £29 if for seven years.

Ganz & Co., of Buda-Pest, offer to light those parts of the Crawford Markets where gas is now used, with 14 arc lamps and 32 glow lamps of 25 candle-power each. They offer also to light the road from Crawford Market to the Apollo Bunder, Church Gate Street, and Elphinstone Circle, with 144 glow lamps of 25 candle-power placed 164 feet apart on opposite sides of the road. In addition they would supply 32 arc lights and illuminate the Clock Tower. The present amount of light now given in the streets is 2,800 candle-power ; their glow lamps alone would give 3,600 candle-power, and the arc lamps 12,800. The annual charge would be 80,000 Rs.

Finally, the Orient Electric Light Company proposed to light the markets and the streets above-mentioned (except from St. John's Church to Colaba point), for two years with 650 lights of 16 candle-power. Their charge would be 5 pice per light hourly.

At a meeting of the Standing Committee of the Municipal Corporation, held June 25th, it was agreed that the commissioner be requested to prepare a special report on these schemes, and that he be authorised to apply to Government for the services of an electrical engineer, and also to expend any sum not exceeding 1,000 Rs. in making any needed scientific enquiries.

AN EXPERIMENTAL PROOF OF OHM'S LAW, PRECEDED BY A SHORT ACCOUNT OF THE DISCOVERY AND SUBSEQUENT VERIFICATION OF THE LAW.*

By Prof. ALFRED M. MAYER.

I PURPOSE giving in this paper a simple and direct experimental proof of Ohm's law $\left(C = \frac{E}{R}\right)$. Generally a more formal statement of this law, with illustrations, are given in text books on physics, and the student is left to infer that its truth is shown by the cumulative evidence given by the immense number of quantitative relations in electrical actions which the law associates, and by the experience that deductions made on the basis of this law agree in measure with the results of experiments. The latter fact is certainly one of the best proofs of the truth of the law; but, nevertheless, the relations between C, E and R are not directly and simultaneously shown to be exactly expressed by $C = \frac{E}{R}$. It is true that some works give experiments to show this relation, but they are so difficult to perform by reason of the difficulty of maintaining constant C, E and R, that the results of the experiments only approximate to those required by the law.

Ohm was led to the conception of this law by *assuming* that the flow of electricity in a voltaic circuit is similar to the flow of heat by conduction in a rod of indefinite extent. Also, his assumptions that the actions of two electrified particles are directly as their distance, and that the electricity is uniformly dense over each cross section of a conducting wire, were directly opposed to the laws and facts well established by Coulomb for statical electricity. It is not surprising that scientific men were slow in adopting the views and theory of Ohm. In his memoir (Die galvanische Kette mathematisch bearbitet von Dr. G. S. Ohm: Berlin, 1827) he states:† "Three laws, of which the first expresses the mode of distribution of the electricity within one and the same body, the second the mode of dispersion of the electricity in the surrounding atmosphere, and the third the mode of appearance of the electricity at the place of contact of two heterogeneous bodies, form the basis of the entire memoir, and at the same time contain everything that does not lay claim to being completely established. The two latter are purely experimental laws; but the first, from its nature, is, at least, partly, theoretical.

"With regard to this first law, I have started from the supposition that the communication of the electricity from one particle takes place directly only to the one next to it, so that no immediate transition from that particle to any other situate at a greater distance occurs. The magnitude of the transition between two adjacent particles, under otherwise exactly similar circumstances, I have assumed as being proportional to the difference of the electric forces existing in the two particles; just as in the theory of heat, the transition of caloric between two particles is regarded as proportional to the difference of their temperatures. It will thus be seen that I have deviated from the hitherto usual mode of considering molecular actions introduced by Laplace, and I trust the path I have struck into will recommend itself by its generality, simplicity, and clearness, as well as by the light it throws upon the character of former methods.

"With respect to the dispersion of electricity in the atmosphere, I have retained the law deduced from experiments by Coulomb, according to which, the loss of electricity in a body surrounded by air, in a given time, is in proportion to the force of the electricity, and to a coefficient dependent on the nature of the atmosphere. A simple comparison of the circumstances under which Coulomb performed his experiments, with those at present known respecting the propagation of electricity, showed, however, that in galvanic phenomena the influence of the atmosphere may almost always be disregarded. In Coulomb's experiments, for instance, the electricity driven to the surface of the body was engaged in its entire expanse in the process of dispersion in the atmosphere; while in the galvanic circuit the electricity almost constantly passes through the interior of the bodies, and consequently only the smallest portion can enter into mutual action with the air; so that in this case the dispersion can comparatively be but very inconsiderable. This consequence, deduced from the nature of the circumstances, is confirmed by experiment; in it lies the reason why the second law seldom comes into consideration.

"The mode in which electricity makes its appearance at the place of contact of two different bodies, or the electrical tension of these bodies, I have thus expressed:—When dissimilar bodies touch one another, they constantly maintain at the point of contact the same difference between their electroscopic forces (potentials).

"With the help of these three fundamental positions, the conditions to which the propagation of electricity in bodies of any kind and form is subjected may be stated. The form and treatment of the differential equations thus obtained are so similar to those given for the propagation of heat by Fourier and Poisson, that even if there existed no other reasons, we might with perfect justice draw the conclusion that there exists an intimate connection between both natural phenomena; and this relation of identity increases the further we pursue it. These researches belong to the most difficult in mathematics, and on that account can only gradually obtain general admission; it is therefore a fortunate chance that in a not unimportant part of the propagation of electricity, in consequence of its peculiar nature, those difficulties almost entirely disappear."

From these premises, and guided by results of experiments made by him and by Ritter, Erman, Jäger, Davy and Becquerel, he arrived at the following conditions as existing in a voltaic circuit.

1. In a homogeneous conductor, forming part of a voltaic circuit, the difference of the electric tensions at any two points of the conductor is proportional to their distance.

2. In different conductors forming part of a circuit, the difference of tensions at two points separated by an interval equal to the unit of length is in the inverse ratio of the section of the conductor and of its coefficient of conductivity. Hence, in different conductors, equal differences of tension correspond to lengths whose electric resistance is the same.

3. At the point of contact of two different conductors, there is a sudden variation of electric tension.

4. If A equals the sum of the electromotive forces, L the resistances, λ the resistance reckoned from a point, m, of the circuit to a point, p, when the tension is zero, the tension at the point, m, is given by the formula,

$$u = A\frac{\lambda}{L}.$$

Ohm eventually arrives at the formula $s = \frac{A}{L}$, which

* *American Journal of Science.*

† See translation, published in Vol. II. of Taylor's Scientific Memoirs, p. 402. London, 1841.

expresses what is generally known as his law. Which formula, he says, "is generally true, and already reveals the equality of the force of the current at all points of the circuit; in other words, it may be thus expressed: The force of the current in a galvanic circuit is directly as the sum of all the tensions, and inversely as the entire reduced length of the circuit, bearing in mind that at present by reduced length is understood the sum of all the quotients obtained by dividing the actual lengths corresponding to the homogeneous parts by the product of the corresponding conductivities and sections."

The words "tension" (*Spannung*) and "electromotive force" used by Ohm are the equivalent of the word *potential*. He was the first to introduce this conception into the theory of the voltaic circuit and to the above words and to *current* and *resistance* he attached precise meanings and showed the relations existing between those quantities. The clear definitions Ohm gave of these terms marked a transition from vague ideas of "quantity" and "intensity" to the clear conceptions of potential, electromotive force, current and resistance. The word *energy* he also used with clear and accurate meaning, as is shown in the following statement: "That the decomposing force of the circuit is in direct proportion to the energy of the current, and, moreover, that it depends on a coefficient, to be derived from the nature of the constituent parts and their chemical equivalents." This was published in 1827, six years before Faraday's researches on electrolysis.

Neither Ohm nor his contemporaries were able to test the truth of the four statements given above as embodying Ohm's theory. It was reserved for Kohlrausch in 1849 to show by very ingenious and accurate experiments that Ohm's statements were true in mode and in measure. Kirchhoff* and Quincke† applied with success Ohm's theory to the flow of electricity in thin conducting plates, or bodies of two dimensions, and the same was done by Smaasen,‡ not only in a plane but in bodies of three dimensions. The most remarkable confirmation of Ohm's law was made in 1876 § by experiments suggested by Maxwell and performed by Chrystal in the Cavendish Laboratory, Cambridge, "in which the testing of this law seems to have been carried to the limit of experimental resources."

Though Ohm's law has thus received such ample verification that it ranks with the best-established laws of nature, yet, as Maxwell says: "Ohm's law must, at least at present, be considered a purely empirical one. No attempt to deduce it from pure dynamical principles has as yet been successful. . . . . The conduction of electricity through a resisting medium is a process in which part of the energy of an electric current, flowing in a definite direction, is spent in imparting to the molecules of the medium that irregular agitation which we call heat. To calculate from any hypothesis as to the molecular constitution of the medium at what rate the energy of a given current would be spent in this way, would require a far more perfect knowledge of the dynamical theory of bodies than we at present possess. It is only by experiments that we can determine the laws of processes of which we do not understand the dynamical theory."

Surely, if an experiment, that is easily made, shows the truth of a law of such theoretical and practical importance as that of Ohm, even if it is one restricted in its range of C, E, and R, but shows within its limitations the relations $C = \frac{E}{R}$ then it should be made by all teachers of physics so that clear physical conceptions of those relations may be given to students. As those who have seen these experiments have deemed them worthy of being more generally known, I now publish an account of them.

In the diagram, fig. 1, the parts of the apparatus are shown, but not at their relative distances apart or in the proper proportions as to size. G is a low resistance Thomson galvanometer. At L is the condensing lens of a lime-light lantern, which is covered with a cap having a rectangular opening it. Across the middle of this slit is a vertical wire. The scale of the galvanometer is at C, distant 165 cms. from the mirror of the galvanometer. The width of the divisions on this scale are 2·5 cms., and the lines are drawn 2·5 mms. in breadth, or $\frac{1}{100}$th the distance apart of the centres of the lines forming a unit of the scale. The scale is at such distance from the galvanometer mirror that the image of the vertical slit just fits in the space of a scale unit, while the breadth of the image of the vertical wire is exactly equal to the breadth of a scale line. This arrangement gives the means of observing a deflection of the beam of light to $\frac{1}{100}$th and $\frac{1}{200}$th of a unit with quickness and accuracy.

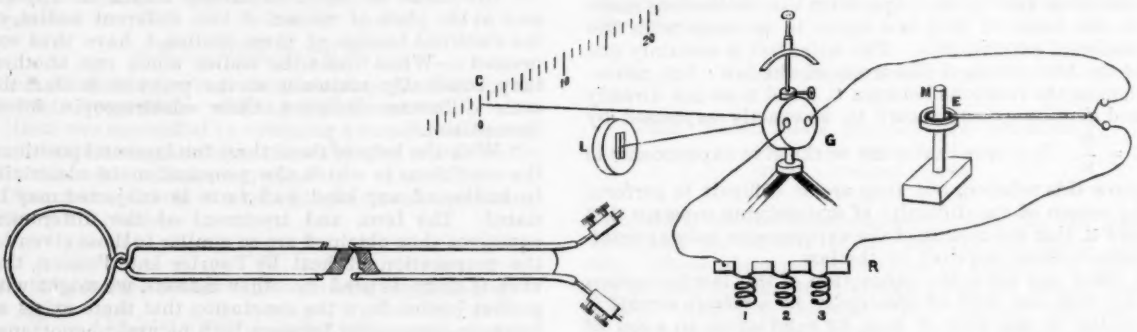

FIG. 1.

FIG. 2.

The image of the slit is so bright and that of the wire so distinct that this method of observing deflections of the galvanometer may be used in broad daylight and the deflections may be read throughout the room.

An incandescent electric lamp with a part of its surface (behind the plane of its filament) silvered may replace the lime light. Thanks to this arrangement, I have been able during many years to make before my class electrical measurements, and to measure the radiation, reflection, refraction, diathermancy, and polarization of radiant heat.

At M is a magnet 25 cms. long and 1½ cms. in diameter. On this magnet slides a wooden disc. At R is box containing 1, 2, and 3 ohms of resistance, made of coils of copper wire.

An insulated copper wire wound at its middle in a circle of one coil, or in a spiral of any number of coils is placed over the magnet and rests on the top of the wooden disc. Fig. 2 shows (one-half size) how this circle of one coil is made. It is bent around a wooden cylinder 3½ cms. in diameter, and then the free ends of wire are bent one-half turn on each other. The free lengths of the wire are then lashed to a light square rod of wood, as shown in figure. The wire and rod are then coated with shellac to cement them firmly to-

* Pogg. Ann., t. lxiv., 1845, and t. lxvii., 1846.
† Pogg. Ann., t. xcvii., 1856.
‡ Pogg. Ann., t. lxiv., and t. lxxii.
§ Brit. Assoc. Rept., 1876, p. 36.

gether. Rings of spirals of 2, 3, 4, 5 and 6 coils are also made in the same manner, but the coils are in spiral, *i.e.*, in one plane, and are then cemented together with shellac between rings of thin card-board.

The length of wire forming each of these rings of spiral coils with the portion on its handle is one meter long.

The resistance of this length of wire, added to the resistance of the lengths between it and G and R, together with the resistance of the galvanometer is (for convenience) made one ohm.

It may be well here to speak of the adjustment of the galvanometer before describing the experiments, for I have noticed in some laboratories and lecture rooms galvanometers which are used not as they should be. I have noticed that the damping magnet formed a considerable angle with the plane of the coil. This was either because the medium plane of the coil was not in the magnetic meridian or because there was considerable torsion in the suspending thread.

In these galvanometers, or, at least, in mine, the median plane of the coil is placed parallel to the faces of the drum of the instrument. The plane of one of these faces is brought in the magnetic meridian of the room, which has been carefully drawn on the table under the vertical centre line of the galvanometer coil, by means of a long magnetic needle mounted like those used on plane tables. A line at right angles to this meridian is now drawn so that its point of intersection with the meridian line shall be exactly under the suspending thread of the mirror. In the vertical plane of the line, drawn at right angles to the meridian, is placed the vertical wire in the slit of the lantern, L, and also the zero line of the scale, C. The scale is parallel to the magnetic meridian. The galvanometer is now placed in the position given above, and the "directing magnet" removed to a distance. The image of the vertical wire at L will now be found on the zero of the scale if there is no torsion in the suspending thread. If it does not come to zero then the head of the rod to which the thread is attached is turned till image of wire coincides with zero of scale, and then the instrument is in adjustment, and it will give deflections as the tangents of the strength of current, or, in other words, the current strength will be directly as the readings on the scale. The magnet, M, is now placed so that it causes no movement of beam from the zero of the scale. The directing magnet, above the coil, is now so adjusted that the time of an oscillation of the magnet of the galvanometer is above five seconds.

The coil, E, over the magnet is put in the circuit of G and R. The wires between E and G and R are twisted and tied together, so that no induced current from the earth's magnetism may be caused by the motions of this part of the circuit. The image of wire is on zero of scale. Now on rapidly lifting the coil from around the magnet, a deflection is produced by the magneto-electric current thus generated. It is sufficient to know that the cause of this current is the quick lifting of the ring with one coil. If we replace this by a ring of two coils, we get twice the deflection, and rings of 3, 4, 5 and 6 coils give 3, 4, 5 and 6 times the deflection given by the ring with one coil. Adopting the conception of the lines of magnetic force, we say that the ring with one coil cuts a certain number of these lines, this cutting of the lines causes the current, and is *the electromotive force*. The ring with two coils makes two cuts of these same lines, or, cuts double the number of lines, the rings of 3, 4, 5 and 6 coils cut 3, 4, 5 and 6 times the number of lines, and hence give 3, 4, 5 and 6 times the electromotive force.

In these experiments the resistance of the circuit has remained constant. Now take the ring with 5 or 6 coils, and let us have one ohm as resistance of circuit. On lifting ring from magnet we get a certain deflection, which we may make exactly equal to a whole number of the units of the scale by sliding up or down the disc on the magnet. We now take out plug of resistance box, and make the resistance of the circuit two ohms. The deflection of the galvanometer magnet now becomes one-half of that of previous experiment, and successively making the circuit with resistances of 3, 4, 5, 6 and 7 ohms, we get $\frac{1}{3}$rd, $\frac{1}{4}$th, $\frac{1}{5}$th, $\frac{1}{6}$th and $\frac{1}{7}$th of the deflection we got with one ohm in circuit.

When these experiments are made with the galvanometer in perfect adjustment, and with the precautions indicated below, the deflections arrive one after the other exactly as the law requires, thus showing, with sufficient precision for a lecture experiment, that the current is directly as the electromotive force, and inversely as the resistance. Indeed, generally, the closest scrutiny does not detect in the scale reading any departure from the law.

Certain precautions are, however, necessary in these experiments. The resistance outside the galvanometer must be of copper wire, for such is the wire of the galvanometer. Also, the whole of the apparatus must be put together the day before we make the experiments, and the room maintained at as constant a temperature as possible, so that the temperature of all parts of the apparatus is the same. The deflections should not exceed 15 divisions of the scale. Thus, if we start with 15 divisions of deflection for a resistance of one ohm we will get 7·5, 5, 3·75, 3, 2·5, and 2·143 deflections for resistances of circuit of 2, 3, 4, 5, 6 and 7 ohms; and if with a constant resistance we obtain a deflection of two divisions of scale with a ring of one coil, we will get deflections of 4, 6, 8, 10 and 12, with rings having 2, 3, 4, 5 and 6 coils.

It is necessary that the coils should be removed from the magnet *very quickly*, otherwise the deflections will not be as the law requires. In other words, the currents produced should be as instantaneous as can be obtained. Instead of rapidly removing the coils by the hand, I have sometimes lashed the coil and their handles to a spring-board with a hole in it, which went over the magnet. By a trigger this spring-board is released. We thus get the same velocity in lifting the coil in each experiment. We have found, however, that the hand of a good experimenter gives precise results. Sometimes I have sent the coil from the magnet by the blow of a stick delivered on the under side of the handle of the coil at its centre of percussion. There is no doubt some departure from the law in these experiments, for it is not possible in such experiments to obtain what is understood by instantaneous currents; and the damping of the magnet by the mirror acting on the air must come into play. Yet I have never seen any but insignificant and barely discernible departures from deflections required by the law. This follows from the small angles of deflections and low velocity of the motion of the galvanometer magnet in the experiments. It is also to be noticed that with a good magnet of the size stated, and with the galvanometer making one vibration in about five seconds, the coil with five turns passes over only 2 cms., or less, of end of magnet, in order that it shall give a deflection of 15 divisions of scale. It is evident that in these conditions a very short time is occupied in cutting the lines of force. If the maximum deflection used is 15 divisions of the scale, the actual angular deflection of the magnets and mirror amounts to only 6° 29′. Yet 15 divisions is quite a length on the scale, being equal to 37·5 cms. But these experiments may be as readily made with a ballistic galvanometer. Then the magnets and coils have to be of larger dimensions.

Experiments similar to those given have served to graduate galvanometers. We have here the means of sending definite amounts of currents through an ordinary galvanometer, and we may thus graduate its angular reading into their relative values in current. The damping of the galvanometer has, however, to be applied to the readings, and then the results may best be put in the form of a curve.

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Ozone.—Mr. Ernst Fahrig is the author of a paper in the *Chemical Trade Journal* for the 19th ult., entitled:—"The phosphorescence produced upon the first contact of ozone with certain fluids."

SOME POINTS ABOUT ALTERNATING CURRENTS.*

By Prof. H. S. CARHART.

THE extensive use of alternating electric currents in the transmission of energy for the purpose of lighting and, to a limited extent, for power, necessitates a more general and exhaustive study of their action than formerly. Alternating current dynamos were early in the field, but their importance was not fully apprehended till after direct current apparatus had come into extensive use, not in fact till transmission at high voltages for incandescent lighting was made possible by the application to alternate current circuits of the inverted induction coil, called a transformer or converter. Since then alternating current apparatus has come rapidly to the front, and many eager investigators have made brilliant applications of it to practical purposes.

The phenomena of alternating currents are so totally different from those of direct currents that the electrician, whose conceptions touching electrical action have been largely derived from the application of Ohm's law, finds himself entirely unable to comprehend alternate working till his views have been modified by an attentive consideration of many new and perplexing facts.

The first of these facts is self-induction, which plays no part in direct current working except on opening or closing the circuit, but which is exalted to a plane of prime importance with alternate currents. It is to Prof. Joseph Henry that we owe the first clear apprehension and lucid explanation of this interesting phenomenon.

When a simple periodic E.M.F. is applied to a circuit so disposed that its different parts act inductively upon one another, then this E.M.F. does work, not simply against the ohmic or ordinary resistance of the conductor, by reason of which heat is generated, but also against a counter E.M.F. of its own creating. We are familiar with this division of work when power is transmitted to an electric motor. The impressed E.M.F. then meets with ohmic resistance generating heat, and with a counter E.M.F. in the motor, the armature of which revolves in a magnetic field, and, in virtue of this counter E.M.F., a part of the energy applied to the circuit is converted into mechanical work at the motor. Energy may thus be stored up by means of the counter E.M.F. arising in the motor.

In an analogous way when energy is applied to an alternating current circuit a part of it is lost in heat, and a part is alternately stored up in the magnetic field and again restored to the circuit. A small portion in practical working, probably a very small portion of the energy, is transmitted outward into space as electrodynamic waves with the velocity of light.

Such a circuit possesses two qualities, resistance and inductance. The former is a property by virtue of which the passage of a current is accompanied by the irreversible transformation of electric energy into heat; the latter is a property by virtue of which the passage of a current is accompanied by the absorption of energy in the form of a magnetic field. A part of the energy spent on the conductor is frittered away in irrecoverable heat, while the other part is associated with the circuit is a recoverable form. When the applied electromotive force diminishes or ceases altogether, this stored-up energy operates to carry the current forward. On account of self-induction a current appears to possess inertia, and so resists any change tending in either the direction of increase or of decrease. A flywheel, to which the turning force is applied to increase the angular velocity, is the mechanical analogue. Suppose no resistance except friction opposes the motion of the wheel. Then a part of the energy applied is converted into heat by friction, and a part is stored up in the motion of the wheel in a recoverable form, to be given out or restored when the turning force is withdrawn. The effect of the inertia of the wheel is to resist the force tending to increase angular acceleration, and to keep up the motion of the wheel in the positive direction when the twisting force is withdrawn. So the inertia or self-induction of a current opposes any change either of increase or decrease in the current. It does more; it continues the current in the positive direction even after the impressed E.M.F. is withdrawn. If the force applied to the flywheel is gradually brought to a zero value, and is then gradually applied with increasing intensity in an opposite direction, the wheel will continue to turn in the positive sense after the force is applied in the negative sense. In other words, the phase of the wheel's motion lags behind that of the applied force, its zero occurring later than the zero of the force. During this period of motion in one direction and force applied in the other, the wheel is doing work on the agent applied to it. While the angular velocity of the wheel is increasing, the agent is doing work on the wheel, and the wheel is storing up energy.

In quite the same way when a simple periodic E.M.F. acts on an inductive circuit, the current lags behind the E.M.F. in phase. It reaches its maximum value after that of the impressed E.M.F. by an interval equal to the angle of lag expressed in time, and passes through its zero value at an equal interval of time later than the zero of E.M.F.

Hence there arises a second fact worthy of particular attention. The maximum current never reaches a value equal to the maximum E.M.F. divided by the resistance of the circuit, but falls short of this by a quantity depending upon the coefficient of self-induction and the rapidity of alternation. By the coefficient of self-induction is generally meant a constant, L, such that the product of this constant and the rate of increase or decrease of the current is the E.M.F. of self-induction. By Ohm's law the current equals the E.M.F. divided by the resistance; with alternating currents in an inductive circuit the maximum current equals the maximum E.M.F. divided by a quantity $R^2 + L^2 p^2$, in which R is ordinary resistance, L is the coefficient of self-induction or the inductance, and p equals $\frac{2\pi}{T}$; T being the period of alternation. The above expression is now often called impedance, or sometimes "apparent resistance."

Another noticeable difference between direct and alternating currents is that while with the former the rate of doing work is the product of the current and the E.M.F., or C.E., in the latter the mean activity is half the product of the maximum E.M.F., the maximum current and the cosine of the angle of lag, or $\frac{1}{2}$ E C cos, ϕ. When the angle of lag is zero the activity is a maximum, or $\frac{1}{2}$ E C. When the lag is 90°, or a quarter of a period, the activity is zero. Thus we have the remarkable combination of a periodic E.M.F. applied to a circuit, a periodic current flowing through it, and still no work done upon the circuit. "In this case there is no frictional dissipation of energy, but simply a give and take of energy between the magnetic field and the source of energy supplying the E.M.F." Thus the mains of an alternating circuit may be joined by a conductor of such high inductance, that approximately no energy will be transmitted across from main to main. Such is the case with a so-called "choking coil," or with a transformer when the secondary circuit is open.

Another point to which the electrician may profitably devote extended contemplation is the measurement of electrical quantities on alternating circuits. Several devices have been invented to serve as current integrators, notably those of Mr. Shallenberger and Elihu Thomson; but these are instruments serving rather for the commercial purposes of central station work than for scientific measurements of precision. The Siemens electro-dynamometer, when properly made of approximately non-inductive resistance, serves for the measure-

* *Western Electrician.*

ment of the mean square of the current. It can be shown that the square root of this mean square is equal to the maximum value of a current, following the simple periodic law, divided by the square root of two.

To measure voltages the ordinary high resistance instruments will not answer at all, because they have high inductance. The Cardew voltmeter, which acts by the heat expansion of a straight wire, and some form of electrostatic instrument are the only device serving for the measurement of a simple periodic E.M.F. These again measure the mean square or the E.M.F., and this bears the same relation to the maximum E.M.F. as the mean square of the current bears to the maximum current. Hence the product of these two quantities equals $\frac{E\ C}{2}$. Neither of these instruments, however, gives any indication touching the important angle of lag, and therefore they give no information respecting the electrical energy in the circuit, nor of the alternate storing and restoration of energy by means of the magnetic field. Dr. Louis Duncan has measured the efficiency of a transformer by means of a huge calorimeter. This method is undoubtedly accurate if carefully applied, but it is scarcely simple enough for general laboratory use. Much remains to be done in this direction.

Very much might be said in favour of electric lighting by alternating currents. Scientific tests have shown that the efficiency of such a system is not so high as its promoters would have us believe. Its great and undoubted advantage lies in its ability to transmit energy to a distance at high voltage, transforming to low voltage at the points where the energy is to be utilised in lighting. For high voltage means small conductors and economy in transmission, and low voltage at the glow lamp is a necessity.

FURTHER NOTES ON THE CAUSES OF DEATH BY ELECTRICITY.*

By DR. EDWARD TATUM.

I NOTICE with pleasure that my results with dogs fully bear out the inference drawn by MM. Brouardel and Bourot† from their human autopsies, namely, that death from electricity is really initiated by cardiac arrest. I must say, however, in regard to autopsies in general, made after accidental electric shocks, that I do not think any (reasonable) number could be convincing as to the fundamental mode of death; for while their number might be large enough to include every lesion that electrical discharges could cause, yet, when several serious lesions appear in one autopsy, there is no way of knowing either the order in which they have been produced or, in fact, that any one of them has really been necessary to the fatal effect. I have, therefore, always thought that the only satisfactory mode of approaching the question would be one in which the action on different organs and functions could be discriminated in order of time.

It now seems certain that (with the animals and conditions that I have employed) cardiac arrest is invariably the real initiation of somatic death—no matter how strong the current may have been, nor what lesions of fatal dimensions may have been caused during the same application.

Permit me to review, very briefly, how I have reached this point, and how I have made an important further advance.

I started out with the object of finding the seat, and if possible the character, of the lesions by which electric currents might kill dogs.

I first eliminated the factor of general injury to muscles and nerves by showing that they could retain their physiological functions not only after the application of a current sufficient to produce somatic death, but even after the direct passage through their substance of currents of more than tenfold the density that the fatal current had averaged in the neck. Neither was the blood discoverably changed by the direct application to isolated portions of it of equally dense currents.

I next eliminated the agency of the respiratory mechanism as a necessary factor by showing, on the one hand, that its functions might be retained and exercised even for several minutes after the heart had executed its last beat; while, on the other hand, I never succeeded in definitely arresting respiratory movements before the heart also had stopped. This I considered a most positive and important advance, for it eliminated from the inquiry everything except the central nervous system and the heart.

Lesions of the central nervous system were dropped from the account on the following grounds:—1. There is no cardiac centre in the central nervous system in the sense that there is a respiratory centre, such, namely, that the continuance of the heart's activity depends on the integrity of the centre, and ceases upon the destruction of the centre. 2. I have apparently passed, without fatal result, through the encephalon alone, considerably stronger currents than have traversed it when the chest has been included in a fatal circuit. 3. No increase in dose seems to be required, either with continuous or alternating currents, to arrest the heart after it has been separated from the central nervous system by the section of both pneumo-gastric nerves.

The only remaining modes that suggest themselves in which electric currents can arrest the action of the heart are three:—

1. By some action on the muscular substance of the heart, by which this muscle is directly deprived of the peculiar physiological property of originating its automatic beats.

2. By a stimulation to physiological activity of the nervous inhibitory mechanism of the heart, which has normally a restraining power over the heart.

3. A joint action, in which the two foregoing share the responsibility.

The part played by physiological inhibition is very clearly shown in the experimental results that I gave in the paper above-mentioned. I there contrasted the effects of battery currents (which deliver their electric energy with the least possible amount of nervous excitation) with rapidly alternating currents, which are far more efficient nerve excitants. The result was, as there stated, that the later currents proved also far more effective in arresting the heart.

That the *whole* of this difference in killing power is accounted for by the difference in nerve-exciting power is shown by the fact that, when the nervous mechanism was paralyzed in ether narcosis, the *difference* in efficiency between the two sorts of currents vanished, while the efficiency of the battery current was not reduced.

While with alternating currents the nerve-exciting property is responsible for at least more than half the result (since that is the lowest possible estimate of the fatal superiority of these currents), still this property is very probably not responsible for the whole of the mischief, since even in this case the currents must reach a certain very respectable density in order to kill.

With battery currents, however, it seems clear that at least nearly all the mischief is done directly to the heart muscle, since the different conditions under which they have been used have failed to show distinctly any factor that could be set down to nerve stimulation. A more direct and striking evidence, however, may perhaps be found in two experiments where I used dogs profoundly poisoned by *curare*.

This drug has the remarkable power of entirely emancipating from nervous influence (at least as far as experiment and inference can determine) all the *red* or *striped* muscular fibres in the body. When a dog is under its influence natural respiration is abolished together with all possibility of voluntary movement. This is not from any paralysis of the muscles, since they respond actively enough to direct electrical stimulation of their substance, but from the fact that they

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* *Electrical World.*

† "Annales d'hygiène publique et de médcine légale," April, 1885.

are cut off from the nervous direction, which they need in order to perform any natural action.

The heart muscle differs from all other red muscles in being what is called automatic; that is, it originates its own activity, and its contractions are not started by any nervous influence (though they are in the normal state unquestionably greatly modified by the nervous mechanism pertaining to the heart). The heart is, therefore, not directly stopped by curare; but, if artificial respiration is practised, it will go on beating regularly and vigorously until the poison is eliminated and the animal recovers.

Yet under this poison the animals succumbed to just about the same current density as when ether alone was used.

These, then, are the conclusions that I think I have legitimately established, for the animals and under the conditions mentioned:—

1. That, in death which follows an electric shock so quickly as to be called sudden, the heart is arrested as soon as, or sooner, than any other serious lesion of tissue or function is produced.

2. That, when a battery current is used, this cardiac arrest is brought about almost exclusively by some direct action upon the muscular substance of the heart, whereby its power of automatic contraction is lost.

3. That, when a rapidly alternating current is used, this cardiac arrest is brought about certainly very largely through the physiological cardio-inhibitory mechanism, although even here the direct action on the muscular substance is probably not without importance.

It is not yet known whether electrical currents, applied as I have described, produce a discoverable histological change in the heart. I have therefore not ventured to formulate the physical process by which the heart muscle is caused to lose its distinctive physiological functions. Perhaps that will have to be left to electricians. Probably the complete explanation—since it involves the as yet undefined relation which subsists between the physical and physiological properties of living matter—is yet a great way off. I am not without hopes, however, of being able to throw additional interesting physiological light upon the matter.

PROF. LODGE'S COMMUNICATION ON "ALTERNATIVE PATH" EXPERIMENTS.

By S. ALFRED VARLEY.

THOSE who regard language as an instrument for word fencing will possibly find much to admire in the communication of Prof. Lodge that appeared in the last issue of the ELECTRICAL REVIEW.

Prof. Lodge does not condescend to reason; he speaks from an elevated pulpit, and seems to expect *our* ignorance to accept unquestioned the utterances of *superior* wisdom. At the same time, with the true instinct of an able artist, he delicately veils and tones down, with learned phrases, what, if only analysed, will be found to be little more than *ipse dixits*. I fear that I myself too often run into an opposite extreme, and tear to tatters what I am discussing by an over-anxiety to give a reason for everything; but I do my best to express myself in common-sense, understandable language; and those who read to learn will give me the credit, I think, of having seriously thought out what I venture to write about.

Now, in the journalistic correspondence which has occasionally occurred between Prof. Lodge and myself, he has never condescended to reason, and he seldom speaks from a level platform; the consequence is I cannot get into touch with him, and, from no fault of my own, I become forced into a more or less antagonistic attitude. Circumstances, combined with traditions, have tended to make me unconventional; I do not, therefore, fit properly into either the square holes or the round holes society delights in, and every-day experience teaches me that not to be of a shape recognised by orthodox Cults is the unpardonable sin which can never be forgiven.

Prof. Lodge has, however, in his last communication shifted his ground a little, and I am thankful for small mercies. He *now* tells us that the spark observed at B is a derived spark. I agree with him that it is a derived spark, and I venture to say it is derived from the demagnetisation of the metallic path, and that it represents the percentage of energy transformed into magnetism in overcoming inertia, and which becomes temporarily occluded in the path, at the time the Leyden jar discharge is occurring.* Now, having reached this stage, I find myself in a position to connect in an intelligible manner the spark at B with the inertia phenomena of *all* closed electric circuits, and what I observe both in galvanic as well as in dynamo circuits helps me to understand what happens when a Leyden jar discharge takes place through a metal path; and, further, as all knowledge reacts I have been able to clear up in my own mind certain difficulties in connection with the transmission of rapid alternations through conductors by studying what is observed when Leyden jars are discharged through metal paths.

Now, I dare venture to assert that neither Sir William Thomson nor Prof. Lodge will take upon themselves to say, in clear unambiguous language, that I am wrong in attributing the spark seen at B to current developed in the conductor during the act of demagnetisation, and in saying, as I do, that this spark arises simply from the completion of the circuit through the short air space that separates the metallically disconnected ends of the wire loop; but at the same time, if the truth be told, these two distinguished physicists would, I believe, do almost anything rather than admit the soundness of my conclusions, for to do so would be tantamount to admitting that I have successfully stormed an important stronghold of the newer theory.

Prof. Lodge says in his communication that the current of a Leyden jar is very strong whilst it lasts, but he gives no reasons why it is so, and in such matters as these the writings of Prof. Lodge and those of mine contrast very strongly; what he has put forward simply as a statement I have demonstrated, and I believe I am the only physicist who has ever undertaken the task of doing so. I have shown the connection that exists between ordinary Leyden jars, decomposition cells, plating baths, storage batteries, and voltaic cells, and I have pointed out that a charged Leyden jar is fairly comparable to a voltaic couple whose internal resistance approaches the infinitely great, and yet, for reasons developed in my articles, a Leyden jar discharge comports itself during an infinitely short interval of time as a voltaic cell whose internal resistance approaches the infinitely small. Men such as Faraday considered themselves to be simply students somewhat older in experience than their pupils, and their efforts were directed to setting their pupils thinking; but all this has been changed since certain mathematical physicists have claimed to be the authorities in electrical science. In place of reasoning, we have authoritative statements from scientific gods, and it is considered the rankest of heresy to question in any way the sensational utterances they from time to time thunder forth.

Now, my contention is that I have fairly analysed Prof. Lodge's so-called alternative path experiments; and I say that these experiments performed by himself demonstrate, as clearly as experiment can demonstrate, a scientific fact that Leyden jar discharges pass through the mass of a conductor. I further say, as I have already stated in my criticism of Sir William Thomson's paper, that what was observed when a cold cylindric iron frame, forming two paths for the alternations to pass through, was placed in the electric welder, did not suggest in *any way* a crowding of currents in the outer skins.

* Reasons have been given at length in the course of the articles, and I have connected, by *consecutive* reasoning, all that I have published.

The communication of Prof. Lodge, published in *Industry*, has reference to my criticism of Sir W. Thomson's paper, but he passes wholly unnoticed the experiment I laid the most stress upon, as bearing more directly on the matter at issue, viz., the crowding of transient currents in the outer skins of conductors; and now Prof. Lodge expresses surprise at my taking exception to his having done so. In my articles I have analysed self-induction, and I have pointed out that on the assumption that my explanation is the true one, the inertia resistance of iron should become reduced after a red-hot temperature has been reached. I believe I am right in saying that no one but myself has hitherto given thought to this matter, and I have not yet had an opportunity of verifying it. Prof. Lodge *now* says *it is* so, no reasons are given, and I am not credited with the suggestion, but the giving me any scientific credit is what he and those brother professors of his, who not so very long ago opposed me in the law courts, are evidently very unwilling to do. Sir William Thomson, in the Court of Sessions, Edinburgh, took credit to himself for having become possessed of a shunt machine in 1880. He said that next to nothing was known of such machines at that period, and the burden of the song sung by the three professors was that as *they themselves* knew very little indeed about shunt machines even in 1880, *how was it possible* for Mr. Varley to design an advance on such machines in 1876.

It is no good pummelling straw, as Prof. Lodge remarks, and the leading horses to a stream if they do not desire to drink is about as useless. The fact that the ELECTRICAL REVIEW, in which the communication of Prof. Lodge appears, also contains the judgment lately given at the Court of Appeal at Edinburgh in the compound winding case, I hail none the less that it is purely accidental. My claims as a discoverer, which certain of our mathematical physicists have been doing their very best to ignore and to spirit away, have now been triumphantly sustained in two law courts. The judgment given in the Court of Sessions declared the evidence of certain highly-distinguished professors to be *neither* reasonable *nor* fair. The Court of Appeal has confirmed this judgment and expressed its surprise that a number of able and distinguished men "*should have been* persuaded" to give the evidence they did.

I have no desire to prolong this discussion. I shall repeat, as soon as I am able, the accidental experiment of Lord Armstrong, to which Sir William Thomson has imparted so much importance; but I think it quite possible that in the mean time we may have promulgated some more of what Prof. Lodge has so happily termed "unique corrections of formulæ."

GAS WORKS AND ELECTRIC LIGHTING.

AT the annual meeting of the North British Association of Gas Managers, held at Perth last week, Mr. S. Stewart, in the course of his presidential address, said :—Having had the experience of supplying a section of Greenock with the electric light for a couple of years, I am able to speak somewhat confidently of the possible results of a gasworks furnishing electric lighting. In Greenock, I may explain, we fitted up two dynamos, each equal to 100 incandescent lamps of 20 candle-power; and they were driven by a turbine water-wheel and gearing. Only one dynamo was run at a time; but both could have been worked if there had been a demand for the light. The plant was erected on ground belonging to the Water Trust some two miles from gasworks; and it was complete in all respects and provided with necessary testing apparatus. Some 25 incandescent lamps were employed in the streets—being put into the ordinary gas lanterns; and part of a sugar refinery was fitted up with 85 incandescent and two arc lamps. The whole of the mains and cables were carefully laid under skilled supervision, and worked with entire satisfaction. During summer only one man was employed; but in the winter months another was taken on during the daytime, renewing and repairing the lamps, &c. Something like 1,000 yards of cable and 2,500 yards of wires were laid, including branch services to lamps, all put underground. The wires were double lead-covered, having high insulation, safety fuses, and distributing boxes. The district lighted outside the Water Trust ground was about 300 yards long by 100 yards wide. The total outlay on plant was £1,630; wages and working expenses came to about £150 per annum, exclusive of interest, depreciation, cost of supervision, and power. Had these been included, as in the case of gas supply, the expenditure would have been three times this amount. The sugar refinery was fitted up by the proprietor at a cost of upwards of £200 for the 85 incandescent and the two arc lamps. They paid the Gas Trust about £100 per annum for the supply of electricity, and 10s. per week to a man for looking after their lights. The expenses for one year, as estimated by the proprietor—including 5 per cent. on the outlay for wires and lamps, the renewal of the lamps and carbons, the payment to the Gas Trust, wages, &c.—amounted to £175; while their gas account for the portion of refinery lighted by electricity came to about £125. Finding, after a second year's experience, that their expenses were increasing, they decided to give it up and return to gas lighting. The Greenock Police Board, objecting to go on incurring an annual outlay for the few remaining lamps, stopped the experiment. If they could have induced parties to fit up a number of lamps equal to the full power of the dynamos and plant, their yearly expenditure would not have been proportionately increased; that is to say, supposing consumers fitted up the plant within their premises, and maintained it and attended to the renewal of the lamps. It is evident that the electric light cannot be supplied at anything like the cost of gas. Gas is the light of all classes of consumers; but the electric light, from its excessive cost, can only be the luxury of the rich.

As to the advisability of gas companies furnishing the electric light, it must be borne in mind that, from the expensive nature of the plant required, the capital necessary to supply a whole town would be so great as to prevent this being done; and all that an electric light company would do would be to select those parts of a town where there were shopkeepers willing to use it for advertising purposes, or whose stocks were such as would be injured by the products of combustion or the heat of gas, or where there were wealthy people willing to have the light for the novelty of the thing. Where gas is sold as cheaply as it is in most towns, there is no risk of the general adoption of the electric light. The introduction of the light must be so gradual that the natural increase in the consumption of gas which takes place in most towns would prevent its effect on the demand for the older illuminant being injuriously felt.

There is no part of a gasworks plant that can be utilised for the production or supply of electricity. The cost of laying cables from a gasworks to the locality proposed to be supplied would, in most cases, be so large that it would be necessary to erect plant in the immediate neighbourhood of the district. If a gas company were to take in hand the supply of the electric light it would necessitate putting capital into a new business having special plant and skilled labour, and supervision entirely different from a gas business. In order to make it pay active competition with the gas business would be needed; and one need hardly add that this can scarcely be done by those who find it requires all their energies to make gasworks pay, and at the same time provide a cheap and efficient light. In my opinion the supply of electricity should be left in the hands of those companies who specially take in hand such work, and gas companies should no more trouble themselves with it than they would with the supply of oil to those who prefer to burn this illuminant instead of gas—oil being a much more active competitor than electricity.

EDINBURGH EXHIBITION.

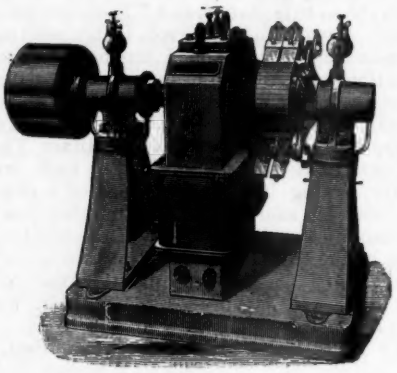
(*Continued from page* 41.)

French Electrical Court.—The interesting collection of exhibits from the Paris Exhibition, for which the French Electrical Court was specially erected, was open for inspection for the first time on the 10th July, and is now almost complete. One side of the building is wholly occupied by the exhibit of the Société Générale des Téléphones, consisting of a very fine collection of instruments, cables, and exchange switchboards. The Administration des Postes et Télégraphes also contributes a number of instruments and specimens of the different cables under its jurisdiction. The Northern of France Railway Company have laid down rails upon which is shown the manner of working railway points electrically, and they also exhibit an electrical capstan for working waggons and turntables. M. Clemancon shows his distribution boards and other specialities for theatres, as fitted by him in five of the Paris houses. There is also to be seen here a section of the Canalisation Electrique Crompton. The Société Cance show a variety of arc lamps ranging from 50 ampères to six, as well as a number of switchboards. The Cance lamps are also to be seen lighting the stand of Messrs. Prentice, Napier & Co. (No. 30). Messrs. Cauderay & Frager have a number of Frager's patent electricity meters suited to various requirements. M. J. O. Mouchel is an exhibitor of his high conductivity copper wire already made well-known in this country by his agents Messrs. Davis and Timmins. Amongst the other exhibitors are Ch. Mildé (bells, indicators, telephones), Richard Frères (electrical and other self-recording scientific instruments), Société Gramme (dynamo, cables), Sautter-Lemonnier (search light).

Telpher Railway.—As stated in a former issue this line was opened on the occasion of the visit of the Lord Mayor of London last month. It has been constructed by the Electrical Engineering Corporation (not the Electric Construction Corporation as erroneously printed in our former reference). There are now two trains running, each consisting of 3 carriages, and each carriage is constructed to hold six persons. On the occasion of the visit of the Institution the electric railway on the overhead conductor system, in course of construction by the same Corporation, was not ready for business, but it is now running.

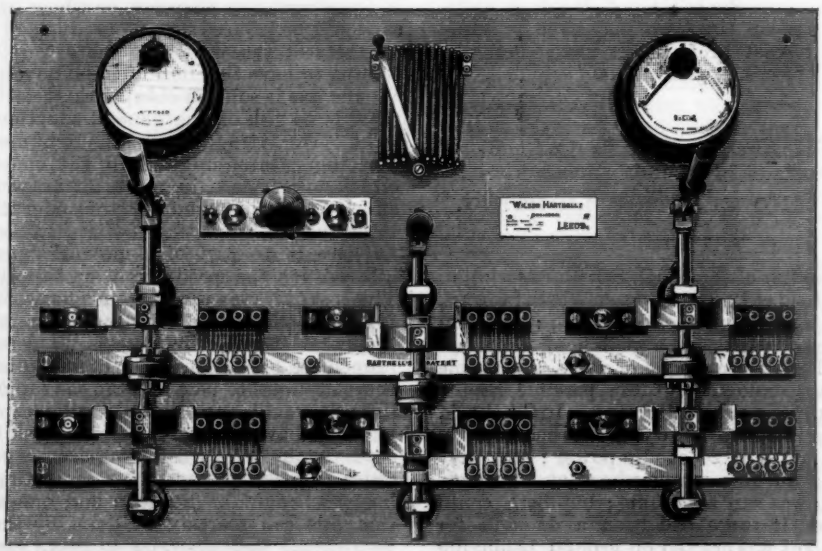
No. 70.—Mr. Wilson Hartnell shows one of his latest type dynamos of 18,000 watts, driven by a horizontal steam engine, of Marshall, Sons and Co., fitted with Hartnell's patent automatic expansion gear. The machine gives 110 volts and 163 ampères at 960 revolutions.

The magnets are made of the softest annealed wrought iron planed all over, and the spindle is 2⅛ inches in diameter, running in bearings of ample length. The commutator is exceptionally large and specially suitable for continuous running. The brush adjustments are novel and very convenient. This machine lights up the stand by some 30 16-C.P. lamps and 6 of 100 C.P. each. It also lights up two adjoining stands by an additional 140 lamps.



It also supplies current to a second dynamo or motor which is placed alongside. The output of this latter as a dynamo is 110 volts, 109 ampères at 1,000 revolutions. The current is taken from the dynamo to a distributing switchboard placed on the right hand side against the wooden partition. This switchboard comprises three main switches, Hartnell's patent compound multiple brush contacts, each intended for about 120 to 140 ampères. It is fitted with voltmeter and variable regulator together with ammeter and short circuit plug. This board is so arranged that any one of three dynamos can be put on to any one of three circuits, but the switches are so arranged that it is impossible for an unskilled man to short circuit one dynamo with another.

On the other side is placed a motor switchboard as used in the transmission of power. Both these boards are of the highest class of work and the principle is one which cannot but commend itself to the trade generally. We illustrate a three circuit board made on the same principle as the switchboards actually shown. In this case the installation is composed



of one dynamo only, and the circuits have about 120 ampères on each.

No. 43a.—Smythe and Payne, Glasgow.—This exhibit contains specimens of electrical fittings manufactured by Messrs. Fowler, Lancaster & Co., of Birmingham, for whom Messrs. Smythe and Payne are agents in Scotland. There are removable fuses, double and single pole, where the fuse is attached to a short bar of porcelain which can be lifted in and out of the clips which form the contacts, also wall connectors, ceiling roses, switches of different patterns, fuse boxes, bell pushes, &c., and specimens of Messrs. Smythe and Payne's new attachment cut-outs.

In this cut-out the heating effect of the current is employed without the necessary fusing of a wire, the device consisting of a mechanical contrivance for breaking the circuit controlled by a spring weight or other force, and held in check by a cord passed round a bare conductor carrying the current. This cord is made of a material that is readily charred or rendered brittle by the action of heat, so that when the conductor round which it is passed becomes heated by an excess of current this attachment cord gives way, allowing the mechanical contrivance to come into action and break the circuit.

As will readily be seen there is hardly any limit to the different patterns and designs in which this cut-out can be made. A few of them are shown in the figs. 1, 2 and 3, taken from photographs of those exhibited.

FIG. 1

In fig. 1, which is a narrow or beading pattern, suitable for branch circuits, the current enters at T_1, passes by the contact holder, H_1, along the bar, B, to the holder, H_2, thence along the conductor, C, and out at

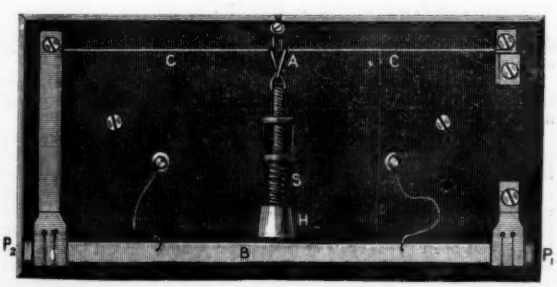


FIG. 2.

the terminal, T_2. The attachment cord, A, A, is passed round the conductor, C, and holds in check the spring, S; when it is burnt through by the heating of the conductor it allows the spring to come into action and pull out the bar, B, from the contacts, H_1 and H_2, thus breaking the circuit.

In fig. 2 the contact bar, B, is knocked out by the hammer, H, when there is an excess of current. The hammer is held up by the cord, A, attached to a peg and passed round the conductor, C; when the cord is charred by the heating of the wire the hammer descends under the action of the spring, S, and knocks out the bar from the contact holders, P_1 and P_2.

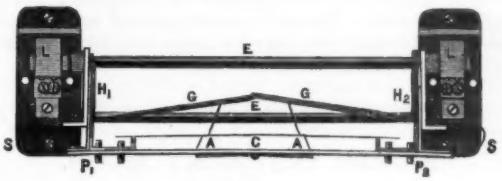


FIG. 3.

In fig. 3 is shown a special form of toggle pattern where the holders are held together by two ebonite rods, E, E, and fitted into spring clips, L, L, fastened to insulators on the wall. The cut-out can then be removed without touching any of the metal parts, and another one ready fitted with a cord immediately inserted in its place, or the cord renewed and the same one replaced; this form is suitable for a main cut-out on a high potential circuit. This pattern, like most of the others, can be fitted with small hooks on the toggles and bar, so that cords can be kept ready tied for insertion in the cut-out immediately after one has given way.

The cut-outs are also made with mercury cups, into which a metal bar dips and makes contact in the usual way; this bar is secured to a lever controlled by a spring or weight at one end, and held down by an attachment cord passed round a conductor carrying the current into the cups. When this cord is charred and gives way the spring, or weight, tilts up the lever arm lifting the contact bar out of the cups.

The device is also applied to switches themselves, so as to do away with the necessity of a separate cut-out. Almost any form of switch can be thus rendered automatic, so as to cut off the current if the latter becomes excessive.

After numerous experiments it was found that a gut or horsehair cord made the best attachment. Other materials were tried, including jute, flax, hemp, silk, leather, cotton, &c. The materials prepared to resist the action of water and used for fishing lines were also found to make good attachments. As the gut cords are stronger for their size than the majority of others, they are more suited to stand the constant strain of a spring or weight.

As the wire does not fuse, it will be seen that the same wire can be used over and over again, provided that the cut-out goes off with the same current each time; repeated experiments have found this to be the case, the wire can thus be permanently soldered down on to the switch or cut-out, thus avoiding two screwed contacts.

A platinum wire forms the best conductor, as it does not oxidise, and since it can be used permanently, the disadvantage of its expense is to a great extent overcome.

Where the lead consists of more than one strand, one or more of the strands can be removed, and the remaining ones fastened down to the cut-out to form the conductor, thus doing away with another screw contact, and avoiding the necessity of a separate wire for the cut-out; even a single wire can be thus employed by filing away some of the conductor where the cord passes round it so as to allow that part to become heated before the other parts of the circuit.

In all the experiments conducted, the cord was never seen to catch fire, even when the wire reached redness before the cord was burnt through, as was the case where some fine wires were tried in connection with coarse strings.

The advantages of this form of cut-out and combination switch are briefly as follows :—

It does not require the wire to be renewed every time the cut-out goes off; this renders it useful for ship lighting where string or tackle of some kind is always procurable, which is not the case with fuse wire of the exact size required.

A cord is a simple thing which can be tied by anyone. A considerable number of screwed contacts are done away with, especially where the lead itself is employed.

White hot wires with sputtering of molten metal is done away with. There is less chance of a wire being inserted, which is too large or too small, thus altering the "go off" point of the cut-out.

EXPERT TESTIMONY AGAIN.

REPORTS on the working of electric tramways are always interesting and serve a useful purpose when drawn up by experts who are thoroughly acquainted with the subject. Two things are essential for the purpose of arriving at a logical conclusion as to whether a new system is as good as, or better than anything that has been done before in a given direction, viz.: Practical experience, and a knowledge of what has been achieved by predecessors. Sometimes an "expert" has either not the time to make himself acquainted with the state of the Art, or the remuneration is not sufficient to allow of the necessary sacrifice of time; under such circumstances it is prudent to refrain from making comparisons. Last week we published a report on the Lineff system, written by Mr. Kapp, who is a great authority on dynamos and transformers, but who, unfortunately, displays some lack of understanding in matters appertaining to electric traction. Mr. Kapp has evidently had no experience in this line, nor does he seem to be acquainted with the statistics published in papers read before scientific societies, particularly those of A. Siemens, Captain Douglas Galton, A. Reckenzaun, F. Sprague, Dr. Bell, Dr. E. Hopkinson, O. T. Crosby, and others. From these he might have learnt a good deal about the energy required for propelling tramcars; this, with well-constructed appliances, amounts to between 5 and 8 H.P. on each car of the ordinary pattern; but at the generating station, from 10 to 16 H.P. is necessary for successful operation, and it is the same whether overhead conductors, underground conductors, or storage batteries are used. Referring to "economy of working," Mr. Kapp states in his report that: "to propel the same car by storage batteries would require an additional weight of 3 to 4 tons, at an expenditure of about 12 horse-power. Making due allowance for loss of power in charging and discharging cells, I find that the total amount of steam power required at the station would, with storage cars, be about double that required by the Lineff system." We should like to know where, and how, Mr. Kapp learnt that 3 to 4 tons of cells are necessary, for, as a rule, about half this weight is used; also, how he ascertained that storage cars require double the steam power? Surely the toy line, 75 yards long, constructed by Mr. Lineff, did not reveal such data, for the Lineff system certainly does not contain conductors of infinitely small resistance, nor does it remove the effects of gradients, and, least of all, does it exclude the possibility of leakage; thus the *estimated* 7½ H.P. per car will be found a long way below the mark when a line on a practical scale has to be planned, and we would advise the consulting engineer to double this figure in future, otherwise he will jeopardise the whole business. It is admitted that the power required to energise and propel the electro-magnet on the Lineff car involves an extra expenditure of ½ to ¾ H.P., therefore it may be assumed, all other conditions being similar, that this system is that much less economical than many other existing electric tramways.

The Lineff method of working with closed conduits is in itself ingenious and sufficiently meritorious; but notwithstanding Mr. Lineff's long letter to us, and Mr. Kapp's report (mainly appendix), we do not anticipate that any sane person will consider that it solves the problem of electric traction. Professional opinions on toy lines are now, we are thankful to say, almost things of the past, and we look in these days for results obtained from actual work on a large scale; we are glad, therefore, to learn that the Lineff method of working is now considered ripe for practical application.

On the insulation resistance of underground conductors and the properties of insulating materials, Mr. Kapp probably would not pose as an authority; yet, he says, that "if the mechanical strain had developed cracks in the bitumen, there would have been sufficient time for water to percolate in the interval of 26 hours which elapsed between the two resistance tests." Now this is an opinion to which our readers may attach whatever value they please, while we proceed to give an example of actual practice. Some years ago, a genial American invaded this country with an insulating material and a method of laying underground wires, which he thought would revolutionise those in use. The insulator was not bitumen, but it served the same purpose and was employed in a similar manner. Our friend secured a contract for laying about half a mile of his underground system, some 60 wires being embedded in a trough containing his material.

The section was laid in summer, and for a few weeks all went right merrily. Not a fault could be found on any of the wires during a series of daily tests, and the inventor was in high glee and predicted that the same happy state of affairs would obtain at the end of as many years. Unfortunately heavy rain soon ensued and lasted, off and on, for a considerable period, and in the course of several more weeks its effects were felt. First one wire fell off in insulation, then another, and before 6 months had elapsed every wire contained in that section had gone bad. The result was entirely due to water lodging around the insulating material and in due course finding its way to the wires, and this, it must be borne in mind, was in a solid block of material, not in a tube or channel. We might instance numerous other examples, but enough has been said to show that in matters of this kind one must await events and not jump to conclusions on the strength of a day's experience.

ST. PANCRAS VESTRY.

AT a meeting of the vestry held on Wednesday, the report of the Electricity Committee was presented for discussion, with the following recommendations attached :—

1. That the seven tenders herein mentioned be accepted.
2. That during the adjournment of the vestry your committee be empowered to clear the site.
3. That the committee be empowered to accept the guarantees for each contract, and to prepare the necessary bonds.
4. That the Finance Committee be instructed to draw a cheque to the order of Prof. Henry Robinson in accordance with the terms agreed upon between the vestry and Prof. Robinson, dated November, 1889, amounting to £994 12s.
5. That a cheque be drawn in favour of Dr. Hopkinson, President of the Institute of the Electrical Engineers, for £105, for services rendered as consulting engineer.
6. That a cheque be drawn in favour of Mr. W. H. Preece, electrician to the Post Office, for £52 10s., for his advice and report upon the plans, specifications and tenders received.

Mr. SWEET, in moving their adoption, observed that it was not proposed to use high tension currents. With regard to a report that the light had been tried in the clearing house of one of the railway companies, and had turned out a failure, he said the committee had waited on the chief of the department, who informed them that the experiment with both the arc and incandescent lamps had been in every way satisfactory, and that a committee was sitting to see whether the light should be made permanent. It was said that the vestry ought to arrange for the lighting of the parish with some public company; but in that case, they must be prepared to waive their rights for a period of 42 years. As sensible men, they would accept their committee's report. Motive power, which companies in London were not making provision for, was provided for in their installation. The committee had had very elaborate specifications and estimates made. Forty-five tenders had been received, and not the lowest merely had been accepted. They had as far as possible, placed them-

selves in actual communication with the manufacturers. The original amount estimated, £60,000, had not been exceeded, notwithstanding that the price of material—copper for instance—and of labour had risen considerably. The committee had been in communication with the Westinghouse Company, which held the patent for the 3-wire system, and although it was proposed to pay £800 or £900 for it, it would enable the vestry to save considerably. When it was suggested that Dr. Hopkinson was himself interested in the 3-wire system the committee took the plans and specifications to Mr. Preece for independent advice, and, in Mr. Preece's opinion, which was appended to the report, Prof. Robinson's installation was to be recommended. Replying to a member, Mr. Sweet further said that the buildings would be erected under Prof. Robinson's superintendence, and that the price for the mains was inclusive of everything necessary for a complete installation.

Dr. FORSYTH argued that if members would read between the lines they would see that Messrs. Hopkinson and Preece merely said that the continuous system was proper for transmitting the supply within the radius of half a mile, and that for over that distance the alternating system was the proper one. The speaker also said that the storage batteries would be a constant source of trouble.

Mr. SWEET, in reply to Mr. Clements, said the report was agreed to on the 25th July. The reason that the printers were busy was the only one he knew of why it was not placed in the hands of members earlier.

Mr. CLEMENTS asked when it was put into the hands of the chief clerk.

The CHIEF CLERK said it had never been in his hands.

Mr. LAMBLE moved that the matter be adjourned until the next meeting of the vestry. He explained that he did so not out of opposition to the scheme which the vestry had pledged itself to, but because very few members had had time to consider the report.

The motion was put to the meeting, and 23 voted for the adjournment and 28 against. Four members hereupon demanded a division, the result of which was that 29 voted for the adjournment and 26 against. A dispute arose as to whether any specific date had been mentioned by the mover, and

Mr. WILSON moved that the vestry meet on the following Wednesday, to consider the report of the Electricity Committee.

Mr. SWEET said that to adjourn the discussion to the date of their next meeting, viz., the first Wednesday in September, would add considerably to the expenses for interest, &c.

Mr. WETENHALL, as a member of the committee, thereupon tendered his resignation.

Mr. WESTACOTT said he had voted for the adjournment because he considered members should have an opportunity to consider a scheme which involved an expenditure ofbetween fifty and sixty thousand pounds; but he suggested that members should be asked to sign a requisition for a special meeting, to be held next week, to rescind the vote for adjournment, by which time every member would have been enabled to consider the report.

This was agreed to, and in the meantime the vote to adjourn the consideration of the question to the second week in September would stand.

A letter was read from Mr. Lazarus, resigning his seat on the Electricity Committee, and shortly afterwards the proceedings ended.

NOTES.

St. Pancras Electric Lighting.—We have received a copy of the Electricity Committee's report adopted on the 25th ult. Doubts seem to have been expressed respecting the practicability of Prof. Robinson's scheme, and Mr. J. E. H. Gordon appears to have gratuitously submitted a competitive plan. The committee, however, places every faith in the ability of their engineer, and in this view they are upheld by the reports of Dr. Hopkinson and Mr. W. H. Preece. This we are pleased to see, for the committee states that the consideration of Mr. Gordon's estimate was more or less forced upon its members. The following contracts, amounting in all to nearly £52,000, have been recommended :—Kirk and Randall, buildings; Babcock and Wilcox Co., boilers, &c.; Willans and Robinson, engines, dynamos, &c.; the Electric Construction Corporation, switchboards and batteries; Mowlem & Co., trenches for five miles of mains; Clark, Muirhead & Co., conductors for five miles of private and 5½ miles public lighting. We congratulate the committee, and also Prof. Robinson, upon the result of their joint labours, and the latter is doubtless more than satisfied that his elaborate scheme should meet with the approval, in almost every detail, of such experts in electric lighting as Messrs. Hopkinson and Preece.

Lighting in Breslau.—The town committee has decided to raise a loan of £50,000 for the purpose of erecting a central station. It is probable that the tender of Messrs. Siemens and Halske will be accepted. This project comprises the immediate erection of a station of 8,000 lamps capacity, with a view to an extension to a total of 30,000 lights. Continuous currents will be used in conjunction with accumulators.

The Berlin-Warsaw Telephone.—A telegram from St. Petersburg states that a Franco-Belgian group of financiers has asked for a concession authorising the laying down of a telephone line between Warsaw and Berlin. The first two minutes' conversation are to be charged 2 roubles, and the following minutes 25 per cent. less. If the Russian Government approves these prices, the telephone would, on the expiration of the concession, revert to the State.

Paddington Lighting.—We understand that in the Paddington district there are to be between 5,000 and 7,000 incandescent lamps in operation by October 1st, supplied from the Manchester Square station. Firms contracting for wiring houses may take this as a hint.

Adoption of the Electric Light at Barnsley.—At a meeting of the Town Council, on Tuesday, it was resolved to accept the tender of the Westinghouse Electric Company to light a portion of the borough at a cost of £17,800.

New Central Station in Berlin.—The Kurfürstendamm Gesellschaft, in Berlin, will shortly commence operations at their new central station, which will supply current to light up the district of Grunewald. The glow lamps, for street lighting, will be arranged two in series. The total cost of the station, including plant and buildings, is estimated at £15,000.

Milan Cathedral.—A company has been formed in Milan for the purpose of electrically lighting the dome of the Milan Cathedral by a large lamp placed on the topmost portion. We wonder what the dividend will be if the company does not supply light elsewhere.

The Lineff System of Electric Traction.—We are informed that the Lineff Electric Lighting and Traction Syndicate, the sole proprietors of the English and foreign patents, have received offers to instal their system on several London and country tramways, and also in Paris, Brussels and Italy. A company will shortly be formed, with a capital of several hundred thousand pounds, to execute the above orders. It may be mentioned as significant of the feeling of tramway companies regarding accumulator traction, that one of the directors of the North Metropolitan Tramway Company recently visited the Chiswick depôt, and expressed himself highly satisfied with the working of the Lineff system.

Dynamos.—The dynamo described in our last issue, and referred to in a previous article, is the type now being manufactured by Messrs. Andrews and Preece, Limited, electrical engineers, Borough Mills, Bradford.

Lighting of New Town Hall, Portsmouth.—The Portsmouth New Town Hall, which has cost upwards of £140,000, has a very complete installation of the electric light; tried a few evenings since it proved highly successful.

Large Turbines.—Messrs. Thomson, Son & Co., of Dundee, have just received an order for twin turbines, each developing 500 H.P., or combined 1,000 H.P. effective. One wheel of similar size has been at work for some years, and these two are supplemental. The type of wheel is parallel flow, largely on the lines of the Jonval turbine, and the fall is 20 feet. The drive is for a large textile factory abroad.

Lightning Strokes.—In the Victorian *Electrical and Telegraphic Journal* we read the following :—The following short, graphic description of a lightning stroke has been sent us by Mr. James M'Carter, of Congupna Road :—"Last Monday night (3rd March), during thunder and lightning, without rain, I 'cut out,' and shortly afterwards was shocked by seeing the office apparently ablaze, and hearing a terrific report, similar to that of a gun, but much louder. I fully expected to find the whole front of the office smashed in, and could hardly credit, on examination, that the only damage done was several of the screw points of arrester fused. The point of one screw was flattened on to the centre plate, resembling a small coin. I scraped this off, and found there was an indent on the earth plate."

The Hub of the Universe again to the Fore.—The *Boston Post*, of June 14th, contains a long account of the improved system of the Union Electric Car Company. We are gravely assured that the devices of the Union Electric Car Company enable the storage battery to be utilised with marked success, as experience abundantly proves. This electrical device, covered by broad patent claims, enables the battery to receive back a portion of its electrical energy while the car is in motion by converting the motor into a generator. Whenever the car is slowed, stopped, or is running on a downward grade, the motor generates a current that is conveyed back into the storage batteries and partially replenishes the loss of electricity entailed by propelling the car up grades or on a level road. Tests have shown that on the Beverly road the maximum return is more than is taken out at any one time. This return current has never before been produced by a series-wound motor, and it is accomplished by charging the field magnets from a supplementary battery. The comparatively small amount of electricity required to run the cars of the Union Electric Car Company, combined with this process of automatic recharging while in transit, make the use of storage batteries perfectly feasible, while the weight of the car with the batteries in place is 1,000 to 2,000 lbs. less than the ordinary electric car operated by the overhead system. The only thing to be done in England now that the Union Company recovers more than is taken out of the battery at any given time, is to seek permission to use the system. Holroyd Smith, Reckenzaun, Elieson, Lineff, &c., are not within miles of this result.

Poole and White, Limited.—On Saturday last week the *employés* of this company took their first annual excursion. The party, which numbered over 30, met at the Elephant and Castle Hotel, Pangbourne, Mr. J. Tryon, the chairman of the company, presiding. The chairman, in proposing the toast of "The Firm," referred to the success which had attended their efforts during the first six months of their existence, and said it was due in great measure to the excellent *esprit de corps* of the *employés*. It was the desire of the directors to establish a reputation for the excellence of their work, and to extend and increase their business and profits by legitimate trading, and not by means of mere financing, and he was pleased to see the way in which every one in the business did their utmost to attain that end. In coupling the toast with the name of Mr. White, he paid a graceful compliment to the ability and zeal with which Mr. White had devoted himself to the interests of the company. Mr. Heaver, who occupied the vice-chair, proposed the toast of "The Board of Directors," to which Mr. Poole suitably replied.

National Art Competition.—The exhibition of the works submitted for the National Art Competition, 1890, by the schools of Art throughout the kingdom, was opened to the public on Monday last, and will remain open until the end of August. The works will be on view in the Enamels Gallery of the South Kensington Museum. The free days are Mondays, Tuesdays, and Saturdays, when the museum is open from 10 a.m. to 10 p.m.

Royal Jubilee Exhibition, Manchester, 1887.—At the final meetings of the Executive Committee and Guarantors' Council, held prior to their dissolution in December last, the following gentlemen were appointed trustees to hold the surplus funds until all outstanding claims were adjusted, and to hand the net balance over to the Whitworth Institute—viz., Sir Joseph C. Lee, Messrs. C. J. Galloway, Oliver Heywood, and William Agnew. A meeting of the trustees was held last week at the secretary's offices, 46, Brown Street, Manchester, when a final statement of accounts was submitted, showing the net cash surplus to be £41,942 18s. 11d., or, together with the value of certain assets not realised, and which have now been handed over to the institute, £43,492 18s. 11d. A cheque for this amount was drawn and handed to Mr. Oliver Heywood for presentation at the meeting of the institute. The affairs of the exhibition were then declared to be finally closed.

Lightning in an Engine Room.—The engine house containing the dynamos which furnish the Viceregal Lodge, Simla, with the electric light, was recently struck by lightning during a storm. At the time there were in the room two native workmen, with Mr. Jordan, the European superintendent. One of the men was struck down, but was brought round immediately afterwards by a plentiful application of cold water; the other man did not fall, but received a severe shock. The lights in the engine house all went out, and the place was in darkness for a short time. Some pieces of mica used in the lightning guard were pierced, and the fastenings torn away.

The London Press and the Proposed Telegraph Subsidies.—The *Leeds Mercury*, in a recent issue, comments strongly on the fact that the London daily Press has refused to publish a very important communication deprecating the proposed subsidy to the Eastern Telegraph Companies. We think, with our contemporary, that the incident reflects little credit upon British journalism.

Improved Fluids for Primary Batteries.—Mr. Theophilus Coad has invented yet another fluid made of the following ingredients :—Nitric acid, mercury, carbonate of potash, carbonate of soda, bichromate of potash, sulphuric acid, common soda and water. A correspondent writes :—"Where is the patent in this? It is as old as the hills."

Electric Light Undertakings.—In the new edition of the "Gas and Water Companies' Directory," published by Messrs. Hazell, Watson and Viney, an electric lighting section has been added, consisting of useful information relating to municipal authorities, companies, and private firms supplying electrical energy for lighting purposes. The following particulars are given of no less than 55 undertakings—name and town, address, date of formation, capital employed, system, capacity of works, price per unit, name of secretary, name of electrician in charge, and area of district supplied. The table appears to have been compiled with care; and the details given must be of interest to almost every one engaged in electrical business.

Removal. — The business of telephonic engineers hitherto carried on at 26, Red Lion Square, under the title of The Electric Telephone Company, is removed to Hermitage Works, Richmond, Surrey, where it will henceforth be carried on by Mr. Ernest J. Gillett.

A Use for the Phonograph. — A use for Colonel Gouraud's pretty toy has been found at last, and in Arthur Law's new farcical play, "The Judge," the cries of a real infant recorded by the Edison phonograph, on Monday, the 21st ult., are reproduced. The Stage has utilised from time to time most of the contrivances invented in the field of electric lighting, and its adoption of the phonograph adds still another instance of the manner in which scientific progress may be turned to profitable account in the World of Art.

Consulting Electricians. — It is very evident that some standard is necessary to which the consulting electrician can adhere, for the unwritten laws of professional etiquette seem quite inadequate. It appears that there are several individuals in existence professing to give advice in electrical matters who are not averse to acting in a manner which should certainly bring them under the serious displeasure of the Institutes to which they belong. What can be thought of any man who, when called in to advise a client who had already arranged to have his requirements carried out by a firm of electrical engineers, coolly says that he (the client) could effect his purpose more cheaply by allowing his professional adviser to hire his own men, and buy the necessary plant for completing the work; and, as if this were not bad enough, he also accepts commissions all round from the firms who supply the goods. We are assured, on unmistakeable authority, that this kind of procedure is being practised, so, how can the *bonâ fide* technical expert, who is ready to give his impartial opinions for a reasonable fee, expect to stand a chance against men who undercut him in the way of payment for professional services, and make up the rest by commissions? One might think that the person requiring technical aid would be cute enough to see through malpractices of this nature, but it appears that such is not the case.

Electric Railway Conduits. — We have received a letter from Henry James Peddie giving a description and illustration of his "conduit rail" for electric tramways. The communication is marked "private," yet he concludes by requesting us to notice his invention in the REVIEW. We can only say that the design is a very neat arrangement, without possessing much novelty, and that under more favourable circumstances we should probably have reproduced his drawings. As it is, we refer those interested to Specification 6359, 1890.

Gas and Electric Lighting on the Continent.—The European Gas Company, which has always taken a place in the front rank of continental gas companies, during the past year only had an increase in their sales of gas of 1½ per cent. Enlarging upon this at the meeting of the shareholders last month, the Chairman (Mr. H. McL. Backler), pointed out that this was the aggregate increase at all the stations, but in some cities the increase was more. At Havre, for instance, the increase was at the rate of 4 per cent., but it was a remarkable thing, he added, that at that station there was much more electric light used than at any other. This was not, however, the only instance, but he had observed the same thing in other continental towns. He saw that at Milan, the consumption of gas exceeded that of former times, although in no city in Italy with which he was acquainted was the electric light used to so considerable an extent. He remarked the same thing in connection with Vienna, Berlin and other cities.

Varley's 1876 Machine.—This dynamo, which was the rock on which the Anglo-American Brush Corporation split in the recent compound-winding case, is now to be seen in the Edinburgh Exhibition, and will no doubt be an object of the greatest interest to electricians visiting the place.

More Demonstration.—On Thursday last week another demonstration was given of the Lineff method of electric traction over the 75 yards of experimental track at the depôt of the West Metropolitan Tramway Company, Chiswick.

New Patents.—Mr. Swinburne has applied for a patent (see p. 142) apparently for five distinct objects. We have hitherto been under the impression that to make inventions valid it was necessary to confine a specification to one object only; perhaps, however, the word "jellygraph" is sufficiently comprehensive to include all the rest.

Dr. Duncan's Motor.—Says the *Electrical World*:—"We are now enabled to give some details of the performance of the experimental machine (Dr. Duncan's motor), which give it unquestioned place as one of the most remarkable developments of dynamo-electric machinery. It weighs 1,100 pounds, and in spite of the fact that its armature is solid cast iron, it developes 10 horse-power at the marvellously low speed of 90 revolutions per minute, and accomplishes this feat with an electrical efficiency of 92 per cent. The commercial efficiency was not measured, but as only 25 lbs. of iron are subject to hysterisis, and at a comparatively low rate of reversal, the losses from this cause should be small." How is it known that the motor actually developes 10 H.P., and why has the commercial efficiency not been calculated if brake tests have been applied?

The Ferranti Mains.—We hear that part of the main route of the London Electric Supply Corporation is up again in the West End, through the failure of the joints in the new Ferranti cables.

The Telegraph Clerks.—We regret to learn that the application of the new scheme is attended with much delay and uncertainty. The vague and ambiguous notices posted in the Central Telegraph Department, to which we referred in a recent issue, have been withdrawn. Interviews with the officials do not seem to be productive of anything definite or satisfactory, and, as several points of vital interest to the staff are still unsettled, a policy of procrastination and mystery is not calculated to have a beneficial or conciliating effect on those interested.

Tudor Accumulators.—The well-known manufactory of Messrs. Müller and Einbeck, at Hagen, Westphalia, has been converted into a limited company, with a capital of £225,000. The entire capital has been taken up by the Allgemeine Elektricitäts Gesellschaft of Berlin, Messrs. Siemens and Halske, and the vendors (Messrs. Müller and Einbeck), in equal parts. The chief office will be situated in Berlin. The Hagen firm, which manufactures the Tudor accumulator, appears to have been very successful commercially, and a German contemporary states that the reason why the Berlin houses have joined it is for the purpose of expanding an existing and prosperous business rather than have to enter into competition with it.

The British Association.—We have received a circular containing the names of members of the various local committees, and the arrangements for excursions, to which special attention will be paid at the forthcoming visit of the association to Leeds.

Dissolution of Partnership.—The partnership between Messrs. W. D. Ramsay and Cecil Walker, electrical engineers, at No. 1, Prince's Mansions, Victoria Street, Westminster (Ramsay and Walker) has been dissolved by mutual consent.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Western Counties and South Wales Telephone Company, Limited.—At an extraordinary general meeting of this company, held at the Grand Hotel, Bristol, on the 30th May, the following special resolution was passed:—"That the articles of association be altered as follows: (*a.*) By striking out the word 'United' wherever it occurs in Articles 38, 39, 74, 83 and 93, and in sub-clauses of Article 71, and substituting the word 'National' therefor, and by striking out the figures £30,000 in sub-clause (A) of Article 71 and substituting £50,000." The resolution was confirmed on the 27th June and filed July 1st.

The annual return, made up to the 13th June, was filed 26th July. The nominal capital is £400,000, divided into 200,000 preference shares of £5 each and 300,000 ordinary of £1 each. The shares taken are 20,000 preference and 281,197 ordinary. Upon 16,600 preference shares the full amount has been called, and the full amount is considered to have been called and paid upon 3,400 preference and 281,197 ordinary. The calls paid amount to £76,233, including £10 paid on 20 shares forfeited. The unpaid calls amount to £6,777.

New Cadogan and Belgrave Electric Supply Company, Limited.—The registered office of this company is now situate at 91, Manor Street, Chelsea.

Taunton Electric Lighting Company, Limited.—The registered office of this company is now situate at St. James Street, Taunton.

NEW COMPANIES REGISTERED.

Plymouth and District Pulsion Telephone Company, Limited.—Capital £4,600, in £1 shares. Objects: To acquire a license of the patent rights granted to Lemuel Millett (1888, 9th June, No. 8,457) for improvements in a mechanical telephone known as the Pulsion telephone. Signatories: W. W. Ricksend, 200 shares; A. Jackson, 40 shares; T. Emerson, 200 shares; A. Latimer, 10 shares, all of Plymouth; Wm. Square, 14, Portland Square, 200 shares; F. A. Buckle, B.A., Stoke, 200 shares. The signatories are to appoint the first directors. Qualification, 100 shares; the company in general meeting will determine remuneration after 10 per cent. dividend has been paid. Registered 24th ult., by Sir Joseph Causton and Sons, 9, Eastcheap.

Edison Phonographic Toy and Automaton Company, Limited.—Capital, £300,000, in £1 shares. Objects: To acquire certain patents for the application of the phonograph to dolls, toys, and automatic figures. Signatories (with 1 share each): E. J. Cook, 28, Pelham Road, N.; J. Guthrie, Florinda Villa, Lancaster Road, Leytonstone; F. B. Liley, 100, Sundmere Road, Clapham; J. H. Coulson, 76, Oakley Road, N.; S. Cooke, 53, Chadwick Road, Peckham; E. J. Newbatt, 57, Cowley Road, Brixton; G. Bridgland, 8, Sparham Road, Brixton. The first directors are Major-General Sir J. W. Campbell, Bart.; H. G. Hemmerde, T. H. Lambert, Col. A. D. Campbell, and Louis Swaley. Qualification, 250 shares; remuneration, £250 per annum each, with £50 additional for the chairman. Registered 26th ult., by Collette and Collette, 2, Victoria Mansions.

British Gas Lighting Improvement Company, Limited.—Capital, £160,000, divided into 6,000 preference shares of £5 each, and 130,000 ordinary shares of £1 each. Objects: To carry on the business of mechanical, gas, and electric engineers and manufacturing chemists in all branches. Signatories (with 1 preference share each):—H. S. King, 65, Cornhill; W. J. Wright, Montagu Mansion, W.C.; F. W. Clark, C.E., South Norwood Park; A. C. Trotman, 12, Thayer Street, W.; J. V. Miller, 39, Stockade Road, Clapham; A. Gooch, 69, Benthal Road, N.; G. Chandler, Woodford. The first directors are:—J. Boustead, Malcolm Guthrie, H. Wollaston Blake, W. L. Hammack, and H. S. King, C.I.E. Qualification, £100 in shares. Remuneration, £200 per annum each, with an additional £100 for the chairman. Registered 28th ult., by Paine, Son and Pollock, 14, St. Helen's Place.

Mulholland, Maugham and Company, Limited.—Capital £5,000, in £10 shares. Objects: To take over the business of R. M. L. Mulholland and B. Maugham, at Ferryhill, Durham, trading as Mulholland, Maugham and Co., and to manufacture and deal in apparatus and things required in connection with electrical engineering, and in particular to construct and lay down cables. Signatories (with 1 share each): R. M. L. Mulholland, P. Mulholland, B. Maugham, T. Iseton, J. Sanders, all of West Cornforth; J. Parker, East Howle; J. W. Mulholland, Hatton, Warwick. The signatories are to appoint the first directors. Qualification, £500 in shares or stock; the company in general meeting will determine remuneration. Registered 29th ult. by Bell & Co., 9, Bow Churchyard.

CITY NOTES, REPORTS, MEETINGS, &c.

Telephone Company of Austria.

Mr. Henry Grēwing presided at the seventh ordinary general meeting of shareholders, held at the company's offices, 53, New Broad Street, yesterday.

The report states:—There has been expended on capital account a further sum of £10,155 11s. 10d. The gross receipts from all sources were £16,524 8s. 8d. After providing for all expenses, including £5,425 4s. 2d. for debenture interest and dividend on preference and interim dividend of 2½ per cent. on ordinary shares, and £3,032 0s. 9d. for royalties and taxes to the Austrian Government, there remains a balance of £1,640 12s. 7d. which, with the amount £3,284 4s. 6d. brought forward from last year, leaves to the credit of profit and loss account for the current year the sum of £4,924 17s. 1d.; of this amount it is proposed to place £3,000 to reserve, and to pay a further dividend of 1½ per cent. upon the ordinary shares (making 4 per cent. for the year), leaving £1,047 2s. 7d. to be carried forward to the next year's accounts.

The Government trunk line between Vienna and Prag, which was alluded to in the last report, was successfully completed and opened for the use of the public towards the end of last year. The undertaking has proved a very great success, and, although the outlay to this company for new switchboards, &c., was considerable, we have reaped the benefit of a fair increase in the number of new subscribers joining the exchange system.

The Austrian Government have now in contemplation the connecting up of other towns worked by this company on the same terms as the Vienna-Prag line, *i.e.*, the Government constructs the trunk line and places the company's exchange subscribers in communication with Vienna, the company having the indirect benefit of the increase of subscribers.

In relation to the prolongation of the company's concessions, the Minister of Commerce has fixed the month of October for opening the negotiations, which, your directors have every hope, will be of a satisfactory nature to the shareholders.

The cordial and satisfactory relations of the Imperial-Royal Telegraph and Postal Authorities and of the municipal bodies with the company remain unaltered.

The Chairman said the progress of the company had been satisfactory during the past financial year, and since the commencement of the current year a further satisfactory increase had taken place, as compared with the corresponding period, of 17,430 florins. He congratulated the shareholders that the year under review was the first of the company's existence in which it had been in a position to declare a dividend on the ordinary shares. It was not that no profits had been made in previous years, but that the necessities of the capital account had been so pressing that every penny of the surplus profits had had to be invested in extending the business. They would now, he did not doubt, reap the benefit of that policy. Their parent, the Consolidated Company, had now made arrangements to supply them with capital to any reasonable amount. He did not doubt that the negotiations pending with the Austrian Minister of Commerce, for the extension of the company's concessions, would have a satisfactory issue. He moved the adoption of the report and accounts, and to declare a dividend on the terms of the report.

Mr. Fitzgerald seconded the motion, which was carried unanimously. Mr. R. E. Bateman was re-elected a director, and Messrs. Deloitte, Dever, Griffiths & Co. auditors of the company; and, with a vote of thanks to the board, the proceedings came to a close.

Elmore's Patent Copper-Depositing Company, Limited.

A MEETING of this company was held at Cannon Street Hotel on Monday. The Chairman (Mr. Carson), apologised for the absence of the president of the company. The directors were very glad to be able to meet the shareholders with an excellent record of progress, shown in the following report:—

"Your directors have pleasure in submitting to you the annexed statement of the company's accounts for the period from the date of the company's formation on January 18th, 1889, to June 30th, 1890.

"In March last, the board disposed of the exclusive British license for the manufacture of wire to Elmore's Wire Manufacturing Company, Limited. The shares of this company (£2 each), were issued at a premium of £1, half of which, in addition to the sum of £75,000, went to our own company. The issue was made to about 500 applicants. A total sum of £105,000 has been received from the wire company, and, in addition, our own company has a further interest contingent upon the allotment later on of the balance of shares of the first issue. Our own company holds

also, all the founders' shares, which are entitled to one-half the profits after 20 per cent. has been paid to the shareholders of the wire company. The board regard these founders' shares as a most valuable asset. It may here be stated that the wire company have received an offer from a strong group of Birmingham firms to take their whole output of wire spirals at remunerative prices.

"The board recommend that out of the sums above-mentioned, an immediate distribution be made of 10s. per share, less income tax, which, with the interim dividend of similar amount paid in April last, makes a total distribution equal to 50 per cent. on the paid up capital for the period named.

"The sum of £20,000, being the estimated original value of the patents for the manufacture of wire, has been reserved, and will be invested or employed in the company's business, as may be deemed most expedient. A further amount of £4,584 8s. 3d. is carried forward, after setting aside £35,000 for the second dividend referred to above."

BALANCE SHEET, *30th June*, 1890.

Dr.	£	s.	d.
To nominal capital—			
100,000 shares of £2 each £200,000, of which there has been issued 70,000 shares, fully paid	140,000	0	0
„ sundry creditors	7,992	12	8
„ amount received on forfeited shares	7	10	0
„ balance brought forward from profit and loss account	39,584	8	3
	£187,584	10	11

Cr.	£	s.	d.
By purchase of patents (£100,000). Less amount reserved from sale of license (£20,000)	80,000	0	0
„ buildings, siding, and wharf	8,011	18	8
„ plant, machinery, loose tools, &c.	11,339	1	1
„ furniture and fittings	199	3	8
„ sundry debtors on open accounts	391	0	4
„ Elmore's Wire Manufacturing Company, Limited	2,111	10	0
„ sundry investments	1,600	3	0
„ cash at bankers	73,763	19	11
„ stocks in trade—			
Raw material	7,714	10	4
Sundry stores	603	3	11
„ preliminary expenses	1,850	0	0
	£187,584	10	11

TRADING AND PROFIT AND LOSS ACCOUNT, *from 18th January*, 1889, to *30th June*, 1890.

Dr.	£	s.	d.
To sundry purchases, wages, and general charges, after deducting stock of raw material and sundry small sales	3,200	6	9
„ maintenance of patents, legal, and professional charges	465	5	6
„ rent, rates, taxes, and insurance	306	2	6
„ income tax	875	0	0
„ stationery, printing, and advertising	166	2	1
„ directors' fees	2,082	7	0
„ balance carried down	77,825	1	4
	£84,920	5	2
To interim dividend of 10s. per share, less tax, paid 18th April, 1890	34,125	0	0
„ directors' percentage of profits under Clause 72 of Articles of Association	4,115	13	1
„ balance carried to balance sheet	39,584	8	3
	£77,825	1	4

Cr.	£	s.	d.
By amount receivable to date in respect of sale of license to Elmore's Wire Manufacturing Company, Limited, less expenses of the formation of that company, (£103,928 5s. 9d.); deduct amount transferred to patents account (£20,000)	83,928	5	9
„ interest	785	0	5
„ transfer fees, &c.	206	19	0
	£84,920	5	2
By balance brought down	£77,825	1	4

The Chairman briefly referred to the various items specified in the report. He attributed the great profits made to the change of policy of the board. They would have been at work much sooner had they acted upon the original plan of having the works at Sheffield; but they discovered that their process was capable of large development, and they would require a large amount of land in order that new work could be carried on alongside the parent company, and under the same management. With that view, they obtained a most suitable site at Leeds. The progress of the works was retarded for several weeks last summer by a strike in the building trade. Further delay in commencing work was caused after the issue of the circular to shareholders, dated February 3rd, 1890, by the breakdown of the first engine supplied for the purpose of driving the dynamos used for depositing. The engine was supplied by a firm of the highest reputation, but had nevertheless proved a complete failure, no useful work having ever been done by it, and it was still incomplete in the hands of the makers, who had undertaken to replace it with an entirely new engine. The breakdown of this engine prevented the management for a period of several weeks from gaining the experience on a large scale with the plant and machinery in the first section of the works, which the board considered indispensable before committing the company to further outlay of capital. The only difficulty experienced subsequently to the breakdown of the engine had been in obtaining perfectly balanced cast iron mandrels or cores for depositing tubes upon. The difficulty had now been fully overcome. The board, however, had now the pleasure to report that everything was proceeding satisfactorily at the works. Two new engines have been delivered, and have been working well for several weeks. The various patent appliances have been tested, and have been proved to work with the utmost regularity. The board consider that the promises held out by the inventors, both as to quality of material and cost of manufacture, have been amply fulfilled. Tubes and wire manufactured on a commercial scale by the company have been submitted to users and experts, and have given the utmost satisfaction, the results being in every case equal to those obtained from samples manufactured in the laboratory, and referred to in the prospectus. At the present time the state of the works is as follows:—Complete offices, laboratory and stores have been provided. A workshop large enough for a 20-ton per week depositing plant has been erected and fitted with engines, machinery and tools. Engine power and dynamos have been provided for depositing 15 tons a week—boiler power for 25 tons a week—and engine and boiler houses, factory chimney, and copper melting furnace have been built on a scale sufficient for the whole works, and for eventual extensions up to 50 tons a week. In addition, a siding connecting the works with the Midland main line has been made. A wharf has been constructed on the canal. The entire property has been walled-in and drained, and two cottages erected. Nothing now remains to be done but to complete the new depositing shed, which will turn out 15 tons per week, and to provide the necessary additional engine power, dynamos, and depositing tanks. The whole of the 20-ton per week depositing plant is in process of completion, and the first section, capable of turning out 5 tons a week, has been satisfactorily at work for several weeks. The works are fitted with the electric light throughout, and an ample supply of copper purchased at prices considerably below the present market quotations has been provided. The demand for the company's products is far in excess of this 20-ton plant, and the prices obtainable are most remunerative. Now that the work connected with preparing for the two exhibitions is over, the whole of the available plant is engaged in the execution of orders.

Several shareholders were dissatisfied that there was not a sufficient sum placed to the reserve, and an amendment was proposed, which was, however, defeated.

A shareholder commented strongly on the defective engine supplied, and considered there was little excuse.

All the members of the board were re-elected, as were the auditors.

Direct United States Cable Company, Limited.

THE twenty-sixth ordinary general meeting of the company was held at Winchester House on the 25th ult., when the report (printed in our last issue) and balance sheet for the six months ending June 30th, 1890, were produced.

The Chairman, Sir John Pender, K.C.M.G., said the revenue for the half-year, after deducting out-payments, amounted to £40,017 1s.; working and other expenses, including income tax, but excluding cost of repairs of cables, amounted to £17,616 5s. 8d., leaving a balance of £22,401 as the net profit of the half-year, making, with £8,318 brought forward from the previous half-year, £30,718 14s. 8d., which had been appropriated thus: interim dividend of 3s. 6d. per share for the half-year ending March 31st, 1890, amounting to £10,624 5s., and a proposed final dividend of 3s. 6d. for the half-year ending June 30th amounting to £10,624 5s.; transfer to reserve fund £8,502; balance forward £968; total £30,719. The revenue for the earlier portion of the half-year showed some falling off as compared with the corresponding period, the tariff being 1s. in each case, but in the latter months an improvement took place which more than recouped the previous falling off, and resulted in a small increase of £390. The reserve fund, after deducting £4,919, cost of repairs, and crediting it with £4,389, interest on investments, and profit on sale of securities, and with £8,502 transferred from the revenue account, amounted to £250,000. The investments were, as heretofore, considered to be worth more than the figure standing in the balance sheet. At their last meeting he expressed the opinion that six months hence it would be necessary to draw special attention to the reserve fund. That fund had been drawn upon to some extent to supplement the company's dividends, and to maintain the 3½ per cent., which otherwise could not have been paid with the 6d. tariff. On the present occasion it would not be necessary to appeal to the shareholders in any way in connection with the reserve fund. It seemed to have turned the corner; they had for the first time during the last two or three years been

adding to instead of taking from it, until it was increased to a very nice round sum. By carrying out the principle laid down, of adding the interest to the reserve fund, and also such a sum as could be conveniently spared from the income, he hoped the company would eventually be placed in a thoroughly independent position, and he believed it occupied such a position that day. He believed their cable stood at a very much lower cost than any other cable in the Atlantic, and that with this large reserve fund no other company could compare with it in value. Standing as it did at, comparatively, a very small price, it was, at any rate, just as good as any other cable in the Atlantic standing at three or four times the price. It was in such good order that the duplex system could be worked upon it. Practically, therefore, the company had the command of two cables, and he was very pleased to say was doing its full share of the Atlantic traffic. As the pool was at present, there was an impression abroad that a single cable was a very dangerous investment. However, when he told them that the cable was one of seven in the Atlantic, they would understand that if the company's cable became incapacitated for twelve months, it would not interfere in the slighest degree with the company's income, as the other cables would be quite sufficient for the traffic; or if the company's cable should be incapacitated for two years, the shareholders would still have an income, and even if it became incapacitated for three years, they would still have a small income. Let it be distinctly understood that if the company stood as a single cable, it was nevertheless guaranteed by six others. That was a very strong position to occupy, and, taking it in connection with the reserve fund, he looked upon the company's cable as the cheapest in the Atlantic. A fault occurred the other day, it was very difficult to repair a fault under £5,000; and it was a consolation to think that these faults were not owing to any real decay of the cable, but were caused by the anchors of fishing boats. The directors had done all they could to induce fishermen when they took up the company's cable, to drop it; they had even undertaken to find them new gear, and in the past few years, although cables had been broken in this manner, the company had received a good deal of consideration on the part of the fishermen. It had always been the directors' policy when a break occurred, not to hesitate in sending out a ship, in whatever weather, to repair it, and the company had been singularly prompt with its repairs. The directors considered it to be the company's duty to the pool to do a fair and full share of the work, and he believed they were doing their fair proportion of it at present. It was encouraging, if not so much so as he could wish, that at the present moment, with a shilling tariff, the company carried as many messages as it did with a sixpenny tariff. Still it was not earning the amount of money such a risky operation entitled it to; but he hoped that by some combination or arrangement material economies might be made which would enhance the company's dividend. They must endeavour to work this out somehow—he was not prepared to say how. Still it was a magnificent property, and while it was necessary that these submarine cables should be efficiently worked, it would be a reflection on all concerned if they could not arrange in some way to give a fair return to their shareholders out of what had become a great political and commercial necessity. The directors would always bear in mind that a company like this should be just as well as generous. The pool was probably stronger than it ever had been. Regarding the Telegraphic Conference, he was pleased to say that while the company's cable had not been very much under consideration, it had neverthless been fairly considered by the other companies, and its demands had been settled upon a basis which ought to be satisfactory to all. It had, at any rate, lost nothing by the conference. In conclusion, he assured the meeting that if by any possibility their old dividend of 5 per cent. could be recovered, they might depend upon the board doing its utmost to bring about that result. He moved the adoption of the report and accounts, and to declare a final dividend of 3s. 6d. per share, free of income tax, making with the interim dividend already paid, a total of 3½ per cent. for the year ending 30th June, 1890.

The motion was seconded by Mr. Ford, and unanimously agreed to.

Messrs. Charles Meara and E. M. Underdown were re-elected directors, and Messrs. J. G. Griffiths, F.C.A., and John Sawyer, F.C.A., were reappointed auditors.

A vote of thanks to the board, and one of sympathy with the chairman in his recent bereavement, were unanimously carried, and the proceedings terminated.

Manchester Edison-Swan Company, Limited.

THE eighth annual meeting of the shareholders of this company was held on Monday at Manchester, Mr. V. K. Armitage, chairman of the company, presiding.

The Chairman, in moving the adoption of the report, said the directors were not as satisfied as they might be with the result of the year's operations. Instead of making something over 10 per cent., as they did last year, they had only made something over 5 per cent. They had worked just as hard in making the 5 per cent. as they did last year in making 10. The real fact was that at this moment there was a manifest falling off all over the country in the demand for small separate installations. There was no doubt whatever that the electric lighting would increase enormously in the near future, but their strong impression was that the increase would be in lighting from central stations. Parliament had been issuing provisional orders for central stations broadcast all over the country, and there could be no doubt that many people who wished to have the electric light were now waiting to see what would be the outcome of these provisional orders. Before they went to the expense of securing private plant they were waiting to see whether they could not draw their supply of electric light from a central station, as they did now in the case of gas. At the same time he had not the smallest doubt that in the near future there would be an enormous increase in the electric lighting industry, and with the experience the Edison-Swan Company had had in this district, and with the name they had acquired for doing good work, he had not the smallest doubt that when the increase came the company would receive at least its fair share of the work that had to be done.

The motion for the adoption of the report was seconded by Mr. I. C. Waterhouse, and carried unanimously.

On the motion of the Chairman, seconded by Mr. Waterhouse, it was further resolved that the profit of £1,647 6s. be appropriated to payment of a dividend at the rate of 5 per cent. per annum (£1,000), carrying forward the balance of £647 6s.

Sir Joseph C. Lee and Mr. I. C. Waterhouse were re-elected directors of the company; and Messrs. Jones, Crewdson & Co. were reappointed auditors.

The Edison and Swan United Electric Light Company, Limited.

THE seventh annual report of this company (printed in our last issue) was presented to the shareholders at the meeting held in the Cannon Street Hotel, on Monday, the 28th ult., Mr. J. Staats Forbes presiding.

The Chairman said it was one of the most embarrassing reports he had ever had to deal with. As it needed no apology, he was scarcely at home with it. He was old enough to remember when the meetings of the Edison and Swan were not quite of this character, because the results were not quite so satisfactory. Good wine needed no bush. The report itself was exceedingly brief; the facts were chiefly to be found in the figures, which he would deal with somewhat generally. The important item, of course, was the profit and loss account, and the important part of it was that the balance to its credit, after making every fair and proper deduction, was the very respectable one of £61,115 3s. 3d., enabling the company to devote it, if the meeting approved, to the full payment of 7 per cent. upon the capital, and a very considerable contribution in respect of those years, which were sadly too long, when, he remembered, there was no dividend to pay. They knew that the dividend upon the ordinary stock to the extent of 7 per cent. per annum was cumulative, i.e., in the years when it was not secured by the profits any balance would be carried forward as a claim on the future. Last year was the first in which they had been able to devote a portion of the profits to wiping out arrears. This year he was happy to say they were able to devote a much larger sum for that purpose. Beginning on the debtor side, the stock on hand brought forward on the 1st of July, 1889, was £25,985 18s. 2d. He reminded honourable proprietors that the character of the business demanded that a very large amount of capital should be locked up in stock. These lamps were of great variety in form and power, and a great many people had very different ideas as to the voltages and the form they needed; and in order to be in a position to supply the demand, the company must have a very large and various stock on hand. On the opposite side of the account there was a very large increase—from £25,985 18s. 2d. to £56,266 8s. 10d. He would say at once that only a very small proportion of it was attributable to the increase in lamps, it having kept pace almost in arithmetical proportion with the increase in sales. A very large portion of the increase was due to purchases of platinum, which, with a certain amount of forecast, the directors had availed themselves of the opportunity of buying at prices which now, he feared, were very considerably exceeded. That platinum was carried into the account at cost price, and was held in reserve. In round numbers, that would account for some £25,000. The demand for platinum was increasing, and the supply did not appear to keep pace with the demand. Putting two and two together, the directors thought the price might go up, and had, therefore, laid in a considerable amount. For wages, purchases, &c., there was an item of £73,719 2s. 1d.; cost of conducting the business, £13,915 19s. 9d.; depreciation of plant, £1,838 17s. 9d.; and, on the other side, sale of lamps, fittings, &c., £118,865 15s. 1d.; interest on investments, £1,442 17s. 1d.; stock in hand already adverted to, £56,266; balance, £61,115 3s. 3d. The proposed appropriation was a very simple one. On one side was the balance of profit, £61,115 3s. 3d., and on the other what was proposed to be done with it. There was the dividend for the year ending 30th December, 1889, at 7 per cent. per annum, £12,371 14s. 7d. of which had been paid as interim dividend, and which amounted to £24,743 9s. 2d., and there was the claim upon the further profit. The accounts were kept from year to year, and the debt against each year wiped out, beginning with the more remote. The directors proposed to pay the balance of the cumulative preference dividend on the A shares, for the year ending 30th June, 1884, at the rate of 4 per cent., and that payment not having exhausted the balance, they proposed a further payment on account of cumulative preferential dividend on the A shares at the rate of 4 per cent. for the year ending 30th June, 1885. With that they had still £8,093 9s. 5d., which they proposed to carry to the reserve fund. Taking next the reserve capital account, there was no substantial alteration observable.

The capital was exactly as in the last account; the only figure affected was that under B shares. Those shares were entitled to one-fourth of the profits, after payment of a cumulative preferential dividend of 7 per cent. per annum upon the A shares. The preferential cumulative dividend of 7 per cent. amounted, on the 30th June, 1890, to £110,609 17s., the balance amount remaining to be wiped out of future profits amounting to £26,257 5s. 5d. There were sundry credit balances, a reserve fund of £4,595 10s. 10d., which, if the shareholders confirmed the resolutions which would be presented to them as to dividends, would be further increased by £8,093 9s. 5d. On the opposite side of the account they had an item of £235,614 9s. 3d., cost of patents, goodwill, preliminary outlay, loss on working, &c., as per last balance sheet. That had been from time to time subject to diminution by writing down realisation of property and so forth to the extent of £2,090 15s. 6d., against which there was a sum of £2,439 5s. 1d., as further expenditure incurred in extension of works or other purposes only chargeable to capital, and the amount now stood at £236,022 18s. 10d. Then there was the item—amount of "B" shares issued as per contra, £117,820. The shares referred to were those given to Mr. Edison and his friends as the value of their interest in the concern. They were deferred to the others, and some day—he hoped not a distant one—they would come in for a fourth of the profits of the undertaking, after paying 7 per cent. Other assets of the concern were:—Manchester Edison Swan Company, Limited, £100,000 "B" shares, at nominal cost, amounting to £12,000; freehold property, £33,396 9s. 7d.; plant and stock, £77,221 2s. 11d., including the large amount of £56,266 8s. 10d. referred to above; office furniture, £256 17s. 2d.; debtors, £15,203 15s. 11d.; investments, £27,500; and cash at banker's and in hand, £31,563 0s. 6d. Not an inconsiderable amount of the company's capital was that item of freehold property. That property of a going concern, embracing as it did, the lamp factory at Ponder's End, which was bought very cheaply indeed, on which some money had been spent, and which was being extended from time to time, in order to meet a possible very great demand for lamps, was set down at the very safe figure of what had been spent upon it. The item, office furniture, was happily disappearing. The debtors included bad and good. The account appeared to be a tolerably satisfactory one, and the shareholders might feel assured that very liberal allowance had been made on all heads on the debit side, and that the balance was absolutely without charge in respect of any cutting down or holding back of responsibilities which the current revenue ought to bear. He moved the adoption of the report and accounts, and to declare the following dividends:—(a) At the rate of 7 per cent. per annum, upon the "A" shares of the company, for the half-year ending June 30th, 1890, making 7 per cent. for the year; (b) 4 per cent., in completion of payment of arrears of cumulative preference dividend, for the year ending June 30th, 1884; and (c) 4 per cent., in respect of arrears of cumulative preference dividend for the year ending June 30th, 1885, to be distributed in accordance with Clause 87 of the articles of association.

The motion was seconded by Mr. Leyland and carried unanimously.

Mr. Shelford Bidwell was re-elected a director, and Messrs. Welton, Jones & Co. were reappointed auditors.

The Chairman, replying to a vote of thanks to the board, said he believed the reason why the company had emerged from what at one time seemed to be a very perilous position, was the strong conviction which the board possessed that the concern was worth fighting for, and the exercise of a great deal of courage, combined with a good deal of forecast and prudence in insisting upon the rights of the company being upheld. Had the board not felt that it had a proprietory which trusted it entirely, and showed its confidence in it upon every occasion of good and evil report, it might in certain moments of anxiety, when the patents were being fought for, have broken down. It was the shareholders' confidence in the board which kept it going, and he was very glad to think that it had been earned, and that it was continued now that the company was in better and smoother water.

The Globe Telegraph and Trust Company, Limited.

THE seventeenth ordinary general meeting of the company was held on Tuesday, the 29th ult., at Winchester House, to receive the report and accounts for the year, &c. Sir John Pender, K.C.M.G., presided. The report states:—

"The net revenue of the company for the year, after deduction of expenses, amounts to £193,499 4s. 10d., which, with the balance of £2,054 10s. 6d. brought forward, make a total of £195,553 15s. 4d. From this amount there has been distributed the sum of £130,806 5s. 8d. in interim dividends, leaving an available balance of £64,747 9s. 8d.

"The directors recommend the payment of a final dividend for the year of 3s. per share on the preference shares, and of 4s. 3d. per share on the ordinary shares, making, with the former distributions, a total dividend for the year of 6 per cent., less income tax, upon the preference and 5 per cent. net upon the ordinary shares (against 4½ per cent. for the preceding year), and carrying forward a balance of £118 18s. 6d.

"Since the last report 80 shares of the German Norwegian Company have been drawn for amortisation and paid off at par less exchange. It is probable that this cable may be acquired by the German Government within a short period. £890 stock of the Submarine Telegraph Company has been paid off, at 107 per £100 stock; there is still a small return to be made by the liquidators. £200 of the Société Carmichael has been paid off. A further 350 American Cable Company's ($100 fully paid) shares with 5 per cent. guarantee of the Western Union Company of New York have been added to the investments.

"The directors record with much regret the loss of their colleague, the late Sir Daniel Gooch, Bart. They have elected Mr. James Pender in his stead.

"In conformity with the articles of association William Ford, Esq., and Sir Henry Daniel Gooch, Bart., two of the directors, retire, but, being eligible, offer themselves for re-election.

"The auditors, Mr. John George Griffiths, F.C.A. (Messrs. Deloitte, Dever, Griffiths & Co.), and Mr. William Griffith, B.A., barrister-at-law, also retire at the meeting, and offer themselves for re-election."

The Chairman said, were he to repeat the remarks made by him on the last occasion, they would be quite appropriate to describe the present state of affairs. On that occasion he pointed out that there was a considerable amount of prosperity prevailing in the telegraph system generally. They had terminated their battle in the Atlantic, and were receiving as many messages at the shilling rate as they had previously been at the sixpenny rate; and, of course, their exchequer and, eventually, their dividends had been materially contributed to. During the last three years the company had been steadily progressing, just as the submarine companies had progressed, and to-day it occupied, on the whole, a very satisfactory position. The company during the year received £198,466 4s. 2d., and after deducting working expenses, there was a balance of £193,499 4s. 10d. A sum of £130,806 had been distributed, leaving an available balance of £64,700 for the final dividends, which the directors recommended, of 3s. on the preference shares, and 4s. 3d. on the ordinary shares, or a net dividend of 5s. per share on the ordinary shares, as against the £4 12s. 6d. paid last year. A small balance was carried forward, but the company, being a trust company, was not bound to pay any large amount to the reserve. Taking the combined dividends of preference and ordinary shares during the seventeen years of the company's existence, they found an average dividend of £4 6s. had been paid. The directors hoped to maintain the level of the present year's dividend, viz., 5 per cent. With regard to submarine companies, it might be said the result of the Paris Conference had not been unfavourable. The policy of these companies was the very broad one, not only doing their work well, but so as to satisfy their customers and the general telegraphing public. The other day the British East African Company held a meeting in London, in which some idea of its work was given; but, unfortunately, it was not stated that the Eastern (Telegraph) Company had at its own cost laid down a cable to connect the British East African Company's important port of Umbassa with the still more important one of Zanzibar. That it had done entirely at its own cost, and entirely in the interest of the British East African Company. The policy of the submarine cables was to follow the flag and to follow the trade wherever they found trade and civilisation alongside, so as to help them on. The changes as regards submarine companies had been very few in the last year, and the Paris conference would not materially affect them. One of these companies, the Eastern Extension, had made an arrangement with the Australian Governments to make the very bold experiment of reducing the tariff from 9s. 4d. to 4s. That had been done by the colonial governments guaranteeing the cable companies 50 per cent. of any loss. But the directors of these companies were so confident that the reduction of the rate would double the traffic, that they had not hesitated to take their part in the risk. The policy of the companies was a broad one, and the broader the more prosperous it was; and as the prosperity of the Globe Company was dependent on the success and prosperity of the cable companies, the shareholders might feel confident that what the other companies did would materially benefit their company. Changes in the company's investments had been very few. It had acquired 350 of the American Cable Company's shares. That company was guaranteed by the Western Union Company of New York, and the shares had been bought at a price which admitted of a fair return. The German Government had taken over all the interests the company had in the German Union Company's shares, and these had disappeared from the statement of the company's assets. There only remained the German Norwegian line, which no doubt would ultimately be acquired by the German Government. Having alluded to the loss sustained by the company in Sir Daniel Gooch, Bart., he moved the adoption of the report and accounts, and to declare a dividend of 3s. per share on the preference shares (less income tax) and 4s. 3d. per share on the ordinary shares (free of income tax, already deducted), making, with the former distributions, a total dividend for the year of 6 per cent. upon the preference shares (less income tax) and 5 per cent. net upon the ordinary shares.

The Marquis of Tweeddale seconded the motion, which was carried unanimously, the retiring directors and auditors were re-appointed, and, with votes of thanks and condolence, the meeting dissolved.

Anglo-American Telegraph Company.

THE report of the directors, to be laid before the ordinary general half-yearly meeting of the proprietors, to be held in the Great Hall, Winchester House, 50, Old Broad Street, in the City of London, to-day, at 2 p.m., states:—The total receipts from

the 1st January to 30th June, 1890, including the estimated balance of £2,247 12s. 8d. brought forward from the last account, are estimated at £152,989 7s. 11d. This amount, however, is subject to revision, as the law-suit between this company and the Paris and New York Telegraph Company is still pending. The traffic receipts show an increase of £2,025, as compared with the corresponding period of last year. The total expenses of the half-year, including the new offices in New York, repair of cables, &c., as shown by the revenue account, amount to £53,945 9s. 7d. One quarterly interim dividend of 12s. 6d. per cent. on the ordinary stock, and of 25s. per cent. on the preferred stock, was paid on the 1st May, 1890, absorbing £43,750, and a second quarterly dividend of 15s. per cent. on the ordinary stock, and £1 10s. per cent. on the preferred stock, will be paid on the 1st August, 1890, amounting to £52,500, leaving a balance of £2,793 18s. 4d. to be carried forward to the next account. The company's repairing ss. *Minia* has been engaged during the past half-year in the repair of the Northern Placentia cable, near Placentia, and of the St. Pierre-Duxbury cable, 270 miles from St. Pierre. The vessel was chartered to the Direct United States Cable Company on two occasions for executing repairs, the remuneration for which will be found in the revenue account. The company's cables and land lines are in good working order. Three new offices have been opened in New York, viz.: No. 8, Broad Street; 16, Beaver Street; and 446, Broome Street. The results are encouraging. No progress has been made since the last report in the litigation between the Anglo-American Telegraph Company and the Paris and New York Telegraph Company, the appeal to the Conseil d'Etat not having come on for hearing. The agreement between the Société du Cable Transatlantique Français (amalgamated with the Anglo-American Telegraph Company in 1873) and the Submarine Telegraph Company, for the laying, maintenance and working of the cable used by this company from Brest to Salcombe expired on the 31st March, 1889. The French and English Governments bought the Submarine Telegraph Company's property, with the exception of the cable above referred to, and, after long negotiation, this company has purchased the Brest-Salcombe cable from the liquidators of the Submarine Telegraph Company for the sum of £2,000, and by arrangement with the associated cable companies this company now maintains and works the cable for an agreed annual payment, which forms a charge upon the joint purse receipts.

The Chili Telephone Company, Limited.

THE first annual report of the directors, for the year ended March 31st, to be presented at the meeting of shareholders at Winchester House, on the 8th August, states:—

The whole of the 40,000 shares offered in August last were subscribed for and allotted, and the full sum of £5 has been since received on each share. The purchase money of the properties in Santiago, Valparaiso, Concepcion, Iquique, Chillan, Talcahuano, Talca, Pisagua, Serena, Coquimbo, Tomé, Penco, Coronel, and Lota, has not yet been paid in full to the vendors. The transfer of these properties was, in due course, made to this company by the vendor company in America; but some shareholders of that company, resident in Chili, obtained an injunction to restrain the legal registration of the transfer, with the view apparently to secure to themselves a larger proportion of the vendor company's assets than would fall to them upon a *pro rata* division with the shareholders in America. The action in the Chilian court is between the vendor company and a small minority of its shareholders. This company is not a party to it, but the board has used, and is using, its best endeavours to remove the impediment to the legalisation of the transfer. Negotiations are reported to be pending to settle the differences by compromise or arbitration; either mode would raise the injunction, and allow registration to be completed. After much correspondence and considerable loss of time, the vendor company appointed this company's general manager in Chili to be the general manager of the vendor company there, and, consequently, since that appointment the business has been conducted without serious inconvenience. The business has been carried on for this company since 1st May, 1889, and the net profit to 31st March, 1890 (after providing for the extraordinary depreciation in currency) amounts to £5,520 8s. 1d. The directors recommend a dividend of 2s. 6d. per share, being a fraction more than at the rate of 5 per cent. per annum from the time the capital has been received to the 31st March last. This will leave £520 8s. 1d. to be carried forward to the account of the next year. The business is progressing satisfactorily.

	1st May, 1889.	31st March, 1890.	Increase.
The number of Subscribers was ...	2,070	2,868	798
The gross revenue was at the rate per annum of	$225,357	$300,346	$74,989
The mileage was ...	2,523	3,320¾	797¾

The above increases were during 11 months only. The general manager in Chili has every confidence that, in the current year, very much more favourable results will be shown, and his estimate of improvement is confirmed by a continuous and rapidly increasing demand for telephones. Negotiations have lately been opened for the sale to this company of the property, plant, and business of the National Telephone Company of Chili (National Co. Telephonos Chile), in Santiago and Valparaiso, and the directors have been advised by cablegram of the purchase of the whole for £36,000. That company was the only competitor with this company, and the directors having now, practically, the control of the telephone business in Chili, anticipate that the company's revenue will be considerably increased; while the requirements of the public will be fully met by necessary extensions and moderate and more uniform charges. In accordance with the articles of association, the Hon. F. Ernest Allsopp and Mr. Thomas Greenwood retire from the board of directors, but, being eligible, offer themselves for re-election. The auditor, Mr. Thomas A. Welton, also retires, and offers himself for re-election.

Spiel's Petroleum Engine Company.

AN extraordinary general meeting of the company was held on the 29th ult. at the offices, Leadenhall Buildings, 11, Leadenhall Street, for the purpose of explaining the present position of the company.

Major J. Heritage (the chairman) stated that an end had been put to all litigation, and questions between the company and Messrs. Shirlaw & Co., who had surrendered the exclusive licence held by them, and the company were fortunate in having come to arrangements with Messrs. Clarke, Chapman & Co., engineers, of Gateshead, whose licence would, however, not be an exclusive license. The company was free to grant licences to other people, with one exception. Messrs. Clarke, Chapman & Co. attached considerable importance to having the exclusive right of manufacturing the installation machines, and that had been given them. The prospects of the company were now much more promising. He moved that the directors be paid £250 per annum, and whenever a dividend of 10 per cent. or upwards shall be paid, an additional 10 per cent. upon the net profits.

Mr. R. A. Tiessen seconded the resolution.

Mr. Neal moved as an amendment that the resolution should stand adjourned for 12 months, in order that a statement of accounts, showing the exact position of the company, might be presented.

Mr. G. Williams seconded the amendment.

Several shareholders expressed a doubt if the company had money in hand sufficient to pay the directors if the resolution was agreed to; but eventually the amendment was negatived.

The Maxim-Weston Electric Company, Limited.—An extraordinary general meeting of the Maxim-Weston Electric Company, Limited, will be held at Winchester House, Old Broad Street, in the City of London, on Thursday next, for the purpose of considering and, if deemed expedient, passing the subjoined extraordinary resolution which is intended to take effect under Sub-section 3 of Section 129, of the Companies Act, 1862, "That it has been proved to the satisfaction of this meeting that the company cannot by reason of its liabilities continue its business, and that it is advisable to wind up the same, and accordingly that the company be wound up voluntarily." Should the resolution be duly passed, a further resolution will be proposed at the same meeting for the appointment of a liquidator or liquidators for the purposes of such winding up.

The Schanschieff Electric Light and Power Company, Limited.—Creditors of this company are to send their names and addresses and particulars of their debts or claims, to Messrs. S. de Lissa and H. A. Campbell, care of Richard Rabbidge, 32, Poultry, London, on or before 4th August next, or to be excluded from any distribution made before such claims are sent in.

The Patent Electric Fire Lighter Company, Limited.—It has been decided to wind up the company voluntarily under Companies Acts, 1862 to 1867. Mr. W. J. Finch, of 21, Osborne Road, Broadstairs, is the liquidator. The assets of the company will be sold to a new company called the New Electric Fire Lighter Company, Limited, partly for cash and partly for debentures.

Woodhouse and Rawson Electric Supply Company of Great Britain, Limited.—The petition for the winding up of this company, presented by Major Goodrich Holmsdale Allfrey, of Wakefield Park, Mortimer, Berks., will be heard before Justice Stirling, on Saturday, the 2nd August.

Elmore's Patent Depositing Company, Limited.—Application has been made to the committee of the Stock Exchange to appoint a settling day and grant a quotation to this company.

The West Coast of America Telegraph Company.—The directors have declared an interim dividend of 3s. per share for 1890.

Chili Telephone Company, Limited.—The directors in their report to March 31st last, recommend a dividend of 2s. 6d. per share, leaving £520 to be carried over.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ending July 25th, amounted to £4,750.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending July 25th, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,679.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (July 24).	Closing Quotation. (July 31.)	Business done during week ending July 31, 1890.	
£					Highest.	Lowest.
250,000	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	97 —100	97 —100		
1,549,160	Anglo-American Telegraph, Limited	Stock	50 — 51	49½— 50⅛	50	...
2,725,420	Do. do. 6 p. c. Preferred	Stock	86 — 87	85 — 86 xd	87½	85¾
2,725,420	Do. do. Deferred	Stock	14 — 14⅛	13⅞— 14⅛xd	14⅛	13 15/16
130,000	Brazilian Submarine Telegraph, Limited	10	11½— 12	11½— 12	11⅞	11⅛
99,000	Do. do. 5 p. c. Bonds...	100	102 —104	102 —104		
75,000	Do. do. 5 p. c. 2nd Series, repayable June, 1906	100	103 —107	103 —107		
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416... ...	3	1⅞— 2	1⅞— 2		
63,416	Do. do. Preference, Nos. 1 to 63,416 ...	2	1⅞— 1⅞	1⅞— 1⅞		
$7,216,000	Commercial Cable, Capital Stock	$100	103 —105	103 —105	105	103½
224,850	Consolidated Telephone Construction and Maintenance, Ltd. ...	14/-	9/16— 11/16	9/16— 11/16	⅝	...
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	5½— 5⅝	5½— 5⅝xd		
16,000	Cuba Telegraph, Limited	10	12¾— 13½	12¾— 13½	13⅛	...
6,000	Do. do. 10 p. c. Preference	10	17 — 18	17 — 18		
12,931	Direct Spanish Telegraph, Limited ... (£4 only paid)	5	3½— 4	3½— 4		
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	9⅛	...
60,710	Direct United States Cable, Limited, 1877	20	10½— 10⅝	10½— 10⅝xd	10 7/16	10 3/16
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14 — 14½	13⅞— 14⅛xd	14 5/16	14
70,000	Do. 6 p. c. Preference	10	15 — 15½	15 — 15½xd	15 7/16	15 5/16
200,000	Do. 5 p. c. Debs. (1879 issue), repay. Aug., 1899	100	108 —111	108 —111		
1,200,000	Do. 4 p. c. Mortgage Debenture Stock	Stock	106 —109	106 —109	108¾	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	14 — 14⅛xd	14 — 14½	14½	14
320,000	Do. 6 p. c. Debentures, repay. February, 1891	100	101 —103	101 —103		
446,100	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. ...	100	103 —106	103 —106		
12,500	Do. 5 p. c. Debentures, 1890, redeem. ann. drawings ...	100	103 —106	103 —106		
367,900	Eastern and South African Tel., Ltd., 5 p. c. Mort. Deb., 1900...	100	100 —103	100 —103	101	100⅛
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4⅛— 5⅛	4⅛— 5⅛		
46,700	Elmore's Patent Copper Depositing, Ltd., Nos. 23,001 to 70,000	2	5⅛— 6	4 — 4⅛xd	5⅜	5 1/16
19,700	Fowler-Waring Cables, Nos. 301 to 20,000 ...(£3 only paid)	5	2 — 2½	2 — 2½		
180,227	Globe Telegraph and Trust, Limited	10	9⅛— 9⅜	8⅞— 9⅛	9 5/16	9 1/16
180,042	Do. do. 6 p. c. Preference	10	15⅛— 15⅜	14⅛— 15⅛	15⅜	14 15/16
150,000	Great Northern Tel. Company of Copenhagen	10	15⅜— 16⅛	15⅜— 16⅛	16	15¾
40,000	Do. do. 5 p. c. Debs. (issue of 1881) ...	100	100 —103	100 —103	102⅛	...
250,000	Do. do. do. (issue of 1883) ...	100	105 —108	106 —109		
9,334	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000 ...	10	12 — 13	12 — 13		
5,334	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11½— 12½	11½— 12½		
41,600	India-Rubber, Gutta-Percha and Telegraph Works, Limited ...	10	18½— 19½xd	18½— 19½	18 15/16	18½
200,000	Do. do. 4½ p. c. Deb., 1896...	100	103 —105	102 —104		
17,000	Indo-European Telegraph, Limited...	25	37 — 39	37 — 39		
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7		
100,000	Do. do. do. 6 p. c. Debentures ...	100	107 —110	107 —110		
49,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000 ...	10	4¼— 4⅜	4 — 4⅛		
436,700	National Telephone, Limited, Nos. 1 to 436,700	5	5 — 5⅛xd	4⅞— 5	5 1/16	4 15/16
15,000	Do. 6 p. c. Cum. 1st Preference	10	12 — 12⅛xd	12⅛— 12⅜	12⅜	...
15,000	Do. 6 p. c. Cum. 2nd Preference (£8 only paid)	10	10⅛— 10⅜xd	10 — 10⅛		
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	1	¼— ⅜	¼— ⅜		
9,000	Reuter's, Limited	8	7⅜— 8⅛	7⅜— 8⅛		
209,750	South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000	1	¼— ...	¼— ⅛xd		
20,000	Do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3¼ only paid)	5	2⅜— 3⅛	2⅛— 3 xd		
3,381	Submarine Cables Trust	Cert.	112 —116	112 —116	114	...
78,949	Swan United Electric Light, Limited ... (£3¼ only paid)	5	5 — 5⅛	5 — 5⅛	5 5/16	5⅛
37,350	Telegraph Construction and Maintenance, Limited	12	43 — 45 xd	42 — 44	43⅜	42½
150,000	Do. do. do. 5 p. c. Bonds, red. 1894	100	100 —102	100 —102		
55,000	United River Plate Telephone, Limited	5	4 — 4⅛	4 — 4⅛xd		
146,000	Do. do. 5 p. c. Debenture Stock... ...	Stock	90 — 94	90 — 94		
100,000	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ...	... ...		
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	9 — 10 xd	9 — 10	9⅛	...
300,000	Do. do. do. 5 p. c. Debentures	100	99 —102	100 —103	101½	100
30,000	West Coast of America Telegraph, Limited	10	5⅜— 6¼	5 — 6 xd	6⅛	5¼
150,000	Do. do. do. 8 p. c. Debs, repay. 1902 ...	100	106 —110	106 —110		
64,572	Western and Brazilian Telegraph, Limited	15	10⅛— 10⅜	10 — 10⅛	10 5/16	10⅛
26,986	Do. do. do. 5 p. c. Cum. Preferred	7⅛	6⅛— 7	6⅛— 7		
26,986	Do. do. do. 5 p. c. Deferred	7⅛	3¾— 4¼	3¾— 4¼		
200,000	Do. do. do. 6 p. c. Debentures "A," 1910...	100	106 —109	106 —109		
250,000	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	104 —107	104 —107		
88,321	West India and Panama Telegraph, Limited	10	2⅜— 2⅝	2⅛— 2⅜	2 1/16	2⅛
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	11 — 11½	11 — 11½	11 5/16	11½
4,669	Do. do. do, 6 p. c. 2nd Preference ...	10	12½— 13½	12½— 13½	13	12¾
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	$1,000	120 —125	120 —125		
179,300	Do. do. 6 p. c. Sterling Bonds	100	99 —101	99 —101		
42,853	*Westmstr. Elec. Sup. Corp., Ord., Nos. 101 to 42,953 (£2 only paid)	5	1½— 1¾	1½— 1⅞		

* Subject to Founders Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7⅛—7⅜.—Electric Construction Corporation (£10 paid), 7¾—8¼. Elmore Copper Depositing Priorities, 5¾—6¼.—Elmore Wire, ¼ dis—par.—House-to-House Company (£5 paid), 5 —5¼.—London Electric Supply Corporation, Ordinary (£5 paid), 1¾—2.—Manchester Edison and Swan Company, £9, (£1 paid), 12/- —14/-.

BANK RATE OF DISCOUNT.—5 per cent. (31st July, 1890).

COUNTY COUNCIL AND ELECTRIC LIGHTING.

On Tuesday last, at the final meeting of the London County Council before the vacation (Sir John Lubbock in the chair), Mr. F. B. Westacott, as Chairman of the Highways Committee, reported that they considered that it would be desirable for the Council to authorise them to deal during the coming vacation with any matters within the scope of their reference which might require immediate action on the part of the Council. The Council was aware that it possessed extensive powers under the Electric Lighting Orders and Acts, which might have to be exercised before it reassembled, and other matters might arise requiring immediate attention. Should this authority be given, the committee proposed to report to the Council, at the first meeting after the recess, what, if anything, had been done under it. They recommended, and the Council resolved:—"That the Highways Committee be authorised to deal, during the ensuing vacation, with any matter within the scope of their reference, which may require immediate action on behalf of the Council."

The same committee reported that they had considered a notice (registered No. 97), dated 16th July, 1890, from the London Electric Supply Corporation, of intention to lay distributing mains in Stanhope Street and Park Lane, as shown upon a plan submitted with the notice. The proposed works were of the same kind as those of this company previously approved by the Council; and the committee recommended: "That the sanction of the Council be given to the works referred to in the notice (registered No. 97), dated July 16th, 1890, of the London Electric Supply Corporation, upon condition that the company do give three days' notice to the Council's engineer before commencing the works; that the mains be laid under the footways, and be kept 9 inches below the underside of the pavement, wherever it is found to be practicable; and that where the mains cross carriage-ways they be kept at the same depth below the concrete."

This was agreed to.

The Parliamentary Committee reported as follows: "We understand that another Electric Lighting Confirmation Bill is to be introduced, and that it will contain orders affecting the City of London. We were authorised on the 3rd June last to present a petition against any order which does not comply with the Council's resolutions of the 28th January and 22nd April, 1890, and we have authorised the preparation and presentation of petitions in the event of any of the orders not complying with the above-mentioned resolutions. We recommend: 'That the employment of two counsel be authorised to support the petitions, if necessary.'" This recommendation was approved.

LEGAL.

Gibbs and Others v. Ferranti.—This appeal came before the Lord Chancellor, Lord Herschell and Lord Morris, in the House of Lords last Thursday. It was an appeal against an order of the Court of Appeal affirming an order of Mr. Justice Kekewich, by which it was ordered that the Gaulard and Gibbs Patent, No. 4,362, A.D. 1882, should be revoked.

Mr. Aston, Q.C., and Mr. J. C. Graham appeared for the appellants; and Sir H. Davey, Q.C., and Mr. Moulton, Q.C., for the respondent.

The patent was granted in 1882 for an alleged invention of a new system of distributing electricity for the production of light and power by secondary generators, the invention being described a consisting in "the employment of an alternating current produced by an electro-dynamo machine, and determining by its passage through an unlimited number of induction coils of special construction the creation of induced currents, whose quality and value depend solely upon the construction of the said induction coils." In 1886 the respondent presented a petition for the revocation of the patent, and the appellants thereupon applied to amend their specification by disclaimer, and the specification was accordingly amended. The Court of Appeal held that the effect of the amendment was to alter the nature of the invention for which the patent had been originally granted, and therefore revoked the patent.

Their Lordships affirmed the decision of the Court below, and dismissed the appeal with costs. Judgment affirmed and appeal dismissed with costs.

The International Cable Company, Limited.—The petition of Alfred Sohier Bolton, a member of a large firm of wire manufacturers at Cheadle, for the winding up of the International Cable Company, Limited, was again before Mr. Justice Stirling on Saturday. Mr. Graham Hastings, Q.C., having stated the case for the petitioner on the 19th inst.

Mr. Buckley, Q.C. (with whom was Mr John Chester), replied on behalf of the company. He said that his lordship had already delivered a judgment in this matter by which, of course, he was bound. The petitioner was a member of a firm of wire manufacturers, and had taken 1,000 shares in the expectation that he would be repaid by a contract for wire for the company. In the former decision his lordship came to the conclusion that the main object of the company was that stated in clause A of the memorandum of association, viz., to establish, maintain and work lines of telegraphic communication between the Azores and points on the coast of Canada and elsewhere. Now, his observation upon that would be this:—Clause A was not to work lines of telegraphic communication under a particular concession, but was to work particular lines of telegraphic communication. His lordship came to the conclusion that the real and primary object was to work the concession from the Portuguese Government, which had been referred to in the prospectus. What his lordship thereby held was that the object of the company was to establish, maintain and work lines of telegraphic communication between this country, Portugal and the Azores; and the question now was—Had that object become impossible, in the sense that this company could not carry it out, and was one shareholder, not supported by others, entitled to say the business had become so impossible that he was entitled to the winding-up order, although the other shareholders did not agree with him, and although no meeting had been called to consider whether this course should be followed or not. Admitting, for the sake of his argument, that the date had passed, the Portuguese Government had neither declared the concession forfeited, nor had they expressly continued it. But, on the 5th inst., a measure to allow, promote, and support by a subsidy the laying and maintenance of a cable from Lisbon to the Azores was passed; and his evidence was that Signor Cavallo, who was largely interested in this company, and who had great influence with the Portuguese Government, expected to obtain the concession under this measure, and would be willing to transfer it to this company. The object of the company, therefore, was, he submitted, not impossible.

Mr. Warrington, for 3,410 shares, which he said represented £34,100, supported the petition.

His Lordship, without calling on Mr. Hastings to reply, said he thought that the order must now go. On the evidence now before him he was perfectly satisfied that the original concession granted by the Portuguese Government, on the faith of the existence of which the shares were subscribed, was completely gone, so completely that a new law had been passed by the Portuguese Legislature authorising a new concession altogether. His view was that this company was formed to work that original concession, and, though the objects of the association were not limited to that particular concession, still that particular concession was mentioned in the prospectus, and by the terms of the prospectus a large portion of the capital was to be appropriated to carrying out that particular concession. That concession was gone. All that now appeared was this; there was a suggestion that the Portuguese authorities were likely to grant the new concession (which by the recent legislation, they had been authorised to grant), to Signor Cavallo, who was said to be willing to transfer that concession to this company. But all that was mere speculation. It was mere speculation that Signor Cavallo would obtain the concession at all, and secondly it was mere speculation that if he did get it he would transfer it to this company. All that could be said was that after the delay which had taken place Signor Cavallo had expressed his willingness—he had not entered into a binding agreement—to transfer it to the company if the Portuguese Government yielded the concession to him. It seemed to his Lordship that there was no reasonable prospect of any such concession being obtained, and, therefore, it was useless to continue this company.

His Lordship accordingly made a winding-up order in the usual form.

Edison & Swan Co. and Others v. Bayley Bros.—This case came on last Saturday, in the High Court of Justice, before Mr. Justice Stirling.

Mr. Aston: Would your lordship allow me to mention what will be a very short matter. It is the case of the Edison & Swan Co. *v.* Bayley, in which I am instructed to say that it has now been arranged between the parties that an order shall be taken on the terms that the defendants shall submit to a perpetual injunction, pay the costs, and take a license. Then I apply to your lordship, supposing this meets with your approval, for a certificate that the particulars of breaches are reasonable.

Mr. Justice Stirling: I am not going to try whether the particulars of breaches are reasonable, or certify anything about it. I know nothing about it; but if you agree, I agree.

Mr. Levett: I appear for the defendants, my lord, and I cannot say that the particulars are unreasonable.

Mr. Justice Stirling: Very well then; take it by consent.

Mr. Aston: If your lordship pleases.

The Lightning Conductor Controversy.—The *Western Electrician*, of Chicago, has published the writings of both Dr. Lodge and Mr. Varley on this subject. The editor, as is the case with Mr. Varley, cannot reconcile himself to the statements of Dr. Lodge, that "iron is as good or even better than copper for the purpose of conveying currents alternating with extreme rapidity," and that the extra resistance of a thin iron wire, used as a lightning conductor, has advantages over those offered by a thick copper rod. We draw the attention of both disputants to another article on the same topic which appeared in our last issue.

PROCEEDINGS OF SOCIETIES.

The Institution of Electrical Engineers.

"The Working Efficiency of Secondary Cells." By W. E. AYRTON; C. G. LAMB, E. W. SMITH and M. W. WOODS, Associates. Read at Edinburgh, Wednesday, July 16th.

(*Continued from page* 110.)

The following table gives a *resumé* of these results, all the discharges being made with 10 ampères until the P.D. fell to 1·8 volts per cell, and all the charges being made with 9 ampères until the P.D. per cell rose to 2·4 volts. Before each rest the cells were charged until the P.D. per cell was 2·4 volts.

Discharge.				Charge.				Percentage efficiency.	
Duration of discharge.	Ampere-hours.	Watt-hours per cell.	Number of curve.	Duration of charge.	Ampere-hours.	Watt-hours per cell.	Number of curve.	Quantity.	Energy.
				Cells in Normal State.					
h. m.				h. m.					
10 12	101·9	201·7	8	11 38	104·5	230·7	9	97·2	87·4
	Rest of 10 days. Cells then charged and discharged many times until brought to a steady working state.								
10 0	100	196	10	11 31	103·8	228·2	11	96·4	85·8
	Rest of 12 days. Cells then charged and discharged many times until brought to a steady working state.								
9 8	91	176·7	12	10 45	96·8	213·2	13	94·1	82·8
	Rest of 16 days. Cells then charged and discharged several times until brought to a steady working state.								
8 24	82·6	161·3	14	9 36	86·2	190·5	15	95·8	84·7
	Rest of 16 days. *First* discharge and charge after rest.								
5 41	56·6	110·5	16	7 54	71·1	158·3	17	Ratio of first discharge *after* rest to last charge *before* rest. 65·4	58·0
								Ratio of first discharge *after* rest to first charge *after* rest. 79·6	69·6
	Cells now charged and discharged several times until brought to a steady working state.								
8 0	80	156·9	18	9 20	83·8	184·6	19	95·5	85·0
	Rest of 16 days. *First* discharge and charge after rest.								
5 21	53·3	104·1	20	6 30	58·5	128·3	21	Ratio of first discharge *after* rest to last discharge *before* rest. 63·6	56·4
								Ratio of first discharge *after* rest to first charge *after* rest. 91·1	81·1
	Cells now charged and discharged several times until brought to a steady working state.								
7 6	76	149·5	22	8 12	78·3	173·5	23	97·1	86·3

From the preceding table it will be seen that, in spite of the continued charging and discharging at the end of each rest, there is a steady falling off in the quantity capacity from 101·9 ampère-hours at the beginning to 76 ampère-hours at the end, and in the energy capacity from 201·7 watt-hours to 149·5 watt-hours. The quantity and energy efficiencies, 97·1 and 86·3 per cent. respectively, at the end are the same as at the beginning. Comparing the first discharge after each of the 16 days' rest with the last charge before the rest, there appears to be a loss of about 36 per cent. in the ampère-hours, and about 43 per cent. in the watt-hours; or, since the normal quantity and energy efficiencies for a discharge immediately following a charge are respectively 97 and 87 per cent., it follows that the rest of 16 days causes a loss of about 33 per cent. in the ampère-hours, and about 30 per cent. in the watt-hours, in addition to the losses that normally occur on a charging immediately followed by a discharging.

From all that precedes, it follows that the previous history of an accumulator produces an enormous effect on its efficiency. If, for example, an E.P.S. accumulator be over and over again carried round the cycle of being charged up to 2·4 volts per cell and discharged down to 1·8 volts per cell, the charging and discharging currents being the maximum allowed by the makers—viz., 0·026 ampère per square inch in charging, and 0·029 ampère per square inch in discharging—the "*working efficiency*" thus obtained may be 97 per cent. for the ampère-hours and 87 per cent. for the watt-hours. If, on the contrary, the cell be constantly charged up before being tested, then for the first few charges and discharges between the above limits, and with the same current-density in charging and discharging, even the *energy* efficiency may be as high as 93 per cent.; whereas, if the accumulator has been left for some weeks, then, although it was left charged, the energy efficiency for the first few charges and discharges will be as low as 70 per cent.

While, on the one hand, our tests show that continued rests of a charged accumulator appear to be far more serious for the accumulator than we had previously imagined, the working efficiency appears to be higher than has hitherto been supposed, since we believe that about 84 per cent. efficiency in the watt-hours is all that the advocates of accumulators have claimed for them.

The smallness of the first discharge after a rest might be due either to a kind of electric short-circuiting and dissipation of the energy, or to some change in the character of the active material converting the energy perhaps directly into heat, or to some of the active material having become disconnected from the plates during the rest, and having fallen down to the bottom of the cell. The smallness of the first *charge* subsequently to the first discharge after the rest, shows that mere electrical leakage during that time has not been the cause of the loss of energy, while the steady increase in the storage capacity brought about by a series of charges and discharges tends to show that rest brings about some change in the nature of the active material.

In all the tests in which the results are given in the preceding table, the charge and discharge were, as already stated, terminated when the P.D. per cell reached a fixed value; it is, therefore, possible that the apparent falling off in the capacity of the cells to store energy may be due to a change in the resistance of the cells produced by the rest. For a change in the resistance of the cells will change the terminal P.D. for a given current flowing through the cells without there being any necessary change in the storage capacity.

It is, therefore, interesting to study the variations in the shapes of the P.D. curves, 8 to 23. First, as regards the charge curves, 9 and 11 are convex everywhere to the axis of time, except just when the charging is commenced; whereas 13, the steady working charge curve after the second rest, rises much more rapidly when the P.D. cell is about 2·3 volts than is the case in the other two curves, then bends over and becomes concave to the axis of time. This peculiarity in curve 13 is, we notice, not very striking in the small reproduction of this curve in the text, but in the original curves, as plotted on large sheets of squared paper from the results of the tests, the difference between curves 11 and 13 is very noticeable.

The following list gives the time in hours and minutes from the commencement of the charging when the P.D. per cell reaches 2·2 volts:—

Curve 9 ... 7 h. 14 m. ... Steady working charge before rests.
„ 11 ... 7 h. 32 m. ... „ „ „ after first rest.
„ 13 ... 7 h. 10 m. ... „ „ „ second rest.
„ 15 ... 5 h. 36 m. ... „ „ „ third rest.
„ 17 ... 3 h. 54 m. ... First charge after fourth rest.
„ 19 ... 5 h. 43 m. ... Steady working charge after fourth rest.
„ 21 ... 4 h. 50 m. ... First charge after fifth rest.
„ 23 ... 4 h. 40 m. ... Steady working charge after fifth rest.

It is clear, then, that the effect of a series of rests is to cause the P.D. to rise much more rapidly in subsequent charges, and the time curve rise of P.D. still remains unusually steep, although at the end of every rest there was a prolonged and uninterrupted series of charges and discharges.

Curves 16 and 20, which give the values of the P.D. for the *first* discharges after the fourth and fifth rest, show that for the first hour from the beginning of each of these discharges the P.D. *rises instead of falling*, as is the case in normal discharges.

If the rapid fall of P.D. at the commencement of a discharge be due to a disappearance of gases occluded in the plates, as some have supposed—or if, as Dr. Gladstone and Mr. W. Hibbert imagine, the charging of a cell causes the acid round the positive plate to become denser than that round the negative, and the mixing of the denser and less dense acid at the commencement of the discharge causes the P.D. to fall—then the absence of this fall at the beginning of a discharge after a long rest would be explained; but neither of these theories would apparently explain the rise of the P.D. obtained by us at the commencement of a discharge after a long rest. Indeed, the fact that it required two discharges and two charges after a long rest before the discharge curve (the third after the rest) acquired its normal form, tends to show that this rise of P.D. at the commencement of the first discharge after a long rest is due to some other cause.

Again, Prof. Duncan and Mr. H. Wiegand have shown in their communication that the diffusivity of the sulphuric acid into the plugs is greatest at the end of the charge, and least at the end of the discharge. Hence, if it be the diffusing out of the strong sulphuric acid from the plugs of the positive plate that causes the rapid fall of E.M.F. on breaking the charging circuit at the end of a charge (see figs. 3, 4, and 11), one would hardly expect that it would be at the *end* of the discharge, when the diffusivity of the acid in the plugs was a minimum, that the rise of E.M.F. on breaking the discharging circuit would be most rapid, but that numerous experiments have shown us to be the case. In fact, curve No. 8, fig. 11, shows that towards the end of the charge the E.M.F. falls from 2·298 to 2·274 volts in 20 seconds after breaking the charging circuit, and similar curves that we have drawn from our experiments on the time rise of E.M.F. on breaking the discharging circuit show that towards the end of the discharge the E.M.F. rises from 1·951 to 1·970 volts in 20 seconds, the latter rate of rise being almost exactly equal to the former rate of fall.

All the rests already referred to occurred when the cells were fully charged; but before these long rests took place the cells, when in their normal state, were on one occasion allowed to remain discharged for 34 minutes, with the following result:—

Cells in Normal State.

Time taken to complete—

Charging 11 h. 38 m.
Discharging 10 h. 10 m.
Next „ 11 h. 37 m.
Next „ 10 h. 12 m.
Next „ 11 h. 37 m.
Next „ 10 h. 11 m.

Cells here remained discharged for 34 minutes.

First charging after rest, 11 h. 50 m.
First discharging after rest, 10 h. 15 m.
Next charging after rest, 11 h. 42 m.

These results emphasise the fact that accumulators are damaged if left discharged even for a short time, and it was for this reason that during the whole of this investigation the cells were never left discharged for a longer time than was necessary to change over the connections from discharge to charge, except on this one occasion when it was desired to ascertain the magnitude of the change produced by leaving the cells discharged for a short time.

It is interesting to notice that the effect of discharging cells too low, or of leaving them discharged, is to increase the times required for the subsequent chargings, whereas the effect of leaving them charged is to diminish the times required for the next chargings.

VIII.—Chemical Action.

Dr. Frankland has shown that probably the discharge of an ordinary accumulator is accompanied by the formation of one or other, or both, of the new lead salts which he has isolated, and which have the formulæ ($Pb_3S_2O_{10}$) and ($Pb_3S_3O_{14}$) respectively. And he concludes that, in view of the great difficulty of electrolytically splitting up the well-known white sulphate of lead ($PbSO_4$), this sulphate is not formed in the ordinary discharge of the accumulator, and is only produced when the cell begins "to sulphate."*

Prof. W. Kohlrausch and C. Heim show in their paper already referred to that the observed variations in the specific gravity of the liquid during charge and discharge agree well with the very simple chemical actions—

Charge.

Positive plate—

$$PbSO_4 + 2\,H_2O + SO_4 = PbO_2 + 2\,H_2SO_4.$$

Negative plate—

$$PbSO_4 + H_2 = Pb + H_2SO_4.$$

Discharge.

Positive plate—

$$PbO_2 + H_2SO_4 + H_2 = PbSO_4 + 2\,H_2O.$$

Negative plate—

$$Pb + SO_4 = PbSO_4.$$

It is to be noticed, however, that the falling off in the specific gravity during discharge is merely a test of the amount of H_2SO_4 that is converted into H_2O, and affords no criterion as to what sulphate of lead is formed by the SO_3 liberated.

During our investigation we observed the variation in the specific gravity of the liquid during about 100 charges and discharges, and the mean of this large number of the fairly consistent results that we obtained showed that, with the accumulators we were testing, the variation in density per ampère-hour was about 0·000232. This result is probably right to within 5 per cent., for our hydrometer would read accurately to about 0·001, which is about 5 per cent. of 0·03, the total change in specific gravity observed during the discharge; and, therefore, as each result is correct to something like 5 per cent., the mean of a hundred results will certainly be correct to within 5 per cent.

On referring to tables of the density of dilute sulphuric acid, we find, by plotting the results, that between the limits we are concerned with—1·2 and 1·17—the change of density is directly proportional to the amount of SO_3 taken from the solution; and, further, that to produce a change in density of 0·01 at 15° C., it requires that 1 gramme of dilute sulphuric acid of density 1·2 should give up 0·01268 of a gramme of SO_3. And as the liquid in each cell weighed about 10,490 grammes when the cell was charged and the density 1·2, it follows that the weight of SO_3 liberated per ampere-hour in each cell, when calculated from the variation in the specific gravity, must equal—

$$\frac{0{\cdot}000232}{0{\cdot}01} \times 0{\cdot}01268 \times 10{,}490 \text{ grammes},$$

or

3·086 grammes.

Further, the electro-chemical equivalent of SO_3 is 0·000414 grammes per coulomb; and since lead sulphate is formed on both the positive and negative plates during the discharge, the weight of SO_3 taken out of the liquid per ampere-hour, when calculated from the electro-chemical equivalent of SO_3, must be

$$2 \times 3{,}600 \times 0{\cdot}000414 = 3{\cdot}041 \text{ grammes}.$$

These two results show a close agreement. At the same time, it is to be noticed that not merely does the amount of SO_3 liberated per ampere-hour come out somewhat higher when calculated from the *mean* change in the specific gravity than when calculated from the chemical equivalent, but the same result is obtained for each separate set of tests.

Mr. G. H. Robertson, working in Dr. Armstrong's laboratory, was so good as to analyse the sediment that fell to the bottom of the cells during the early part of the investigation, when in the discharges the P.D. was allowed to fall to 1·6 volts per cell. The mixture was found to contain—

An indication of uncombined metallic lead,
A trace of antimony,

40·95 per cent. of combined lead	} *i.e.*, 47·3	per cent. of	PbO_2	
6·35 „ „ oxygen				
34·63 „ „ lead	} *i.e.*, 50·74	„ „	$PbSO_4$	
5·36 „ „ sulphur				
10·75 „ „ oxygen				
	98·04			

so that 1·96 per cent. consisted of metallic lead, antimony, and dirt.

The composition of the sediment showed a close approximation to PbO_2, $PbSO_4$, which consists of—

44·08 per cent. of PbO_2
55·92 „ „ $PbSO_4$

PbO_2, $PbSO_4$, in fact, contains—

76·33 per cent. of Pb
5·91 „ „ S
17·76 „ „ O

and the sediment contained—

75·58 per cent. of Pb
5·37 „ „ S
18·05 „ „ O

Dr. Frankland's salts may be represented as $PbO_2\ 2(PbSO_4)$ and $2(PbO)\ 3(PbSO_4)$ respectively, whereas the analysis of the deposit in our cells showed that it was certainly neither of these lead salts, but, instead, had almost the exact composition of PbO_2, $PbSO_4$.

In spite of accumulators with pasted plates having been in use now for nine years, the chemical action that takes place during the different stages of the charge and discharge has only been conjectured, and, odd as it seems, no decisive experiment appears to have been made to settle this much debated question. Various analysis have been made by different chemists of salts of lead acted on in certain ways with sulphuric acid, but apparently not of actual accumulator plates in action. We are therefore now, with the assistance of Mr. Robertson, making a complete investigation of the chemical state of the plugs of both the positive and negative plates at all stages of the charge and discharge of an 1888 E.P.S. type of accumulator in good condition. As this investigation, however, involves the chemical analysis of

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Contributions to the Chemistry of Storage Cells." Proc. Roy. Soc., vol. xlvi., 1889, p. 304.

a large number of specimens, it will take some time yet to complete.

In order to observe what changes took place in the temperature of the cells during charge and discharge, the temperature of one of the cells under test was observed from time to time, as well as the temperature of the air and the temperature of an adjacent cell through which no current was being passed. The following temperature results, which were obtained during the steady discharges and charges after the first rest of ten days (curves 10 and 11), are a sample of the observations taken. The discharge in each case commenced directly the P.D., in charging, had reached 2·4 volts per cell, and the charge in each case commenced directly the P.D., in discharging, had fallen to 1·8 volts per cell.

H. Wiegand in America, and described in their joint investigation already referred to.

From the last table we see that the rise of temperature of the cell during charging may, after allowing for changes of temperature of the room, be either about 1·3° C. or 0·77° C., while the fall of temperature during discharging may have either of the two preceding values. It is further interesting to notice that the rise of temperature during the charging has the higher or the lower of these two values, according as the fall of temperature during the previous discharge had the higher or the lower value.

On plotting the differences between the temperatures of the working and the idle cell, and the corresponding times given in the last table, we obtain the dotted line, 24 (fig. 8), for the time fall of temperature during the first and third discharge, curve 25

Date.	Time.	Cell under test. State.	Temp.	Temperature of Air.	Temperature of Idle cell.	Time from beginning of discharge or charge.	Difference between temperature of cell under test and temperature of idle cell.	Rise or fall of temperature during a complete discharge or charge, compared with temperature of idle cell.
1889.	Hrs. min.		Degrees C.	Degrees C.	Degrees C.	Hrs. min.	Degrees C.	
July 10th ...	1 10	Charged	19·95	18·75	18·6	0 0	1·35	− 1·25 during discharge.
„ ...	11 20	Discharged	18·6	18·6	18·5	10 10	0·1	
„ ...	16 55	Charging	19·6	19·1	18·84	5 35	0·76	
„ ...	21 6	„	19 9	19·0	18·9	9 46	1·0	+ 1·2 „ charge.
„ ...	22 50	Charged	20·2	18·8	18·9	11 30	1·3	
July 11th ...	7 55	Discharging	18·65	18·25	18·1	9 5	0·55	− 0·70 „ discharge.
„ ...	8 50	Discharged	18·8	18·5	18·2	10 0	0·6	
„ ...	11 38	Charging	19·05	18·6	18·4	2 48	0·65	
„ ...	15 10	„	19·3	18·8	18·5	6 20	0·8	
„ ...	19 50	„	19·7	19 0	18·7	11 0	1·0	+ 0·77 „ charge.
„ ...	20 25	Charged	20·1	19·0	18·73	11 35	1·37	
„ ...	21 42	Discharging	19·95	18·95	18·85	1 22	1·10	
July 12th ...	5 40	„	18·72	18·75	18·75	9 20	−0·03	− 1·40 „ discharge.
„ ...	6 20	Discharged	18·72	18·75	18·75	9 55	−0·03	
„ ...	7 50	Charging	19·3	18·65	18·7	1 30	0·6	
„ ...	10 30	„	19·5	19·0	18·78	4 10	0·72	
„ ...	12 40	„	19·61	19·1	18·77	6 20	0·84	+ 1·33 „ charge.
„ ...	17 45	Charged	20·40	19·26	19·1	11 25	1·30	
„ ...	21 30	Discharging	19·95	19·25	19·1	3 45	0·85	
July 13th ...	0 22	„	19·7	19·1	19·1	6 37	0·6	
„ ...	2 55	„	19·73	19·2	19·16	9 10	0·57	− 0·67 „ discharge.
„ ...	3 52	Discharged	...	...	...	10 7	...	
„ ...	3 58	Just started charging ...	19·78	19·08	19·15	0 8	0·63	
„ ...	10 20	Charging	20·0	19·2	19·15	6 28	0·85	
„ ...	12 0	„	20·05	19·2	19·15	8 8	0·90	+ 0·77 „ charge.
„ ...	14 20	„	20·30	19·25	19·2	10 28	1·1	
„ ...	15 30	Charged	20·6	19·4	19·2	11 38	1·4	

Variation of temperature during discharge and charge.

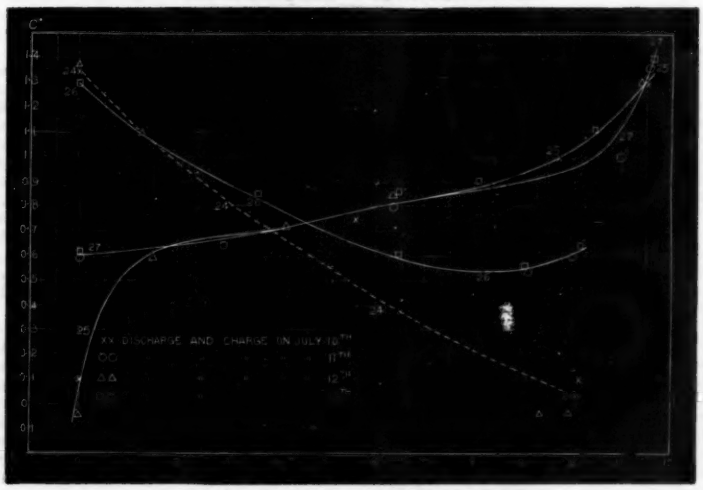
Difference of temperature of working cell and idle cell.
XX DISCHARGE AND CHARGE ON JULY 10TH
Hours from the beginning of the discharge or charge.

FIG. 8.

From the preceding table we see that, while during the charge the cell rises in temperatare, during discharge, on the contrary, it actually falls; hence, in spite of the production of heat due to resistance, the cell is actually cooler at the end of a discharge than at the beginning—a result possibly due to the splitting up of the sulphuric acid during the discharge. This cooling of accumulators during discharge, which we noticed early in our experiments, was also observed at about the same time by Prof. Duncan and

for the time rise of temperature during the first and third charge, curve 26 for the time fall of temperature during the second and fourth discharge, and curve 27 for the time rise of temperature during the second and fourth charges. 24 is dotted, since temperature readings were only taken at the beginning and end of the first and third of these discharges. In the case of the second and fourth of the discharges here referred to, as well as in all the four charges, several observations of temperature were made.

From the curves it appears that towards the end of the discharge and at the beginning of the charge, one or other of two things may happen—either the temperature in the discharge may go on falling, as in the dotted line, 24, or it may begin to rise again, as in 26; whereas, in the charge, either the temperature at the beginning may rise considerably, as in curve 25, or it may only increase slightly, as in curve 27.

It would therefore appear that during the latter part of the discharge one or other of two chemical actions can take place; and these two actions have, for some reason or other, taken place alternately in the four discharges under consideration. But, curiously enough, these four discharges—which took place on July 10th, 11th, and 12th, 1889—occurred with extreme regularity; so that when the time curves were drawn, even on a large scale, for each of these discharges, they coincided exactly and produced a single curve, which is shown, greatly reduced, as curve 10 on the sheet of curves given in the earlier part of the paper. And, similarly, for the four corresponding charges the four time curves all coincided exactly, producing a single curve, which is shown, greatly reduced, as curve 11 on the same sheet. It, therefore, seems as if one or other of two chemical actions might take place during the latter portion of the discharge and during the earlier part of the charge, and yet, curiously enough, when the current is kept absolutely constant the time variation of the P.D. is exactly the same, no matter which of these two chemical actions takes place.

About a year later another set of *continuous* temperature observations was made for many days and nights with the same cells, the current in discharging and charging being, as before, 10 and 9 ampères respectively. The higher P.D. limit was, as before, 2·4 volts per cell, but the discharge was in each case in this second set of continuous discharges and charges, stopped at 1·9 instead of 1·8 volts per cells. As the regulation of the current day and night was in these later experiments in 1890 effected by hand, it was not kept quite as constant as when the automatic regulator was

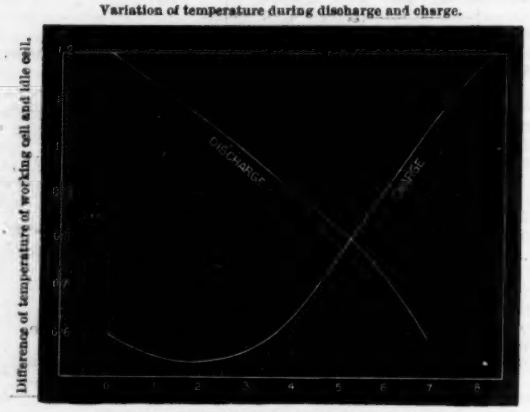

FIG. 9.

employed. Hence the time curves for the excess temperature in discharging and charging, when plotted, were not found to be as regular as in the previous case. But they were quite regular enough to give the general shape of the sets of temperature curves for discharge and charge which are shown in fig. 9.

It will be observed that in these experiments not merely does the excess of the temperature of the working cell over that of the idle cell fall during the discharge, but it actually continues to fall at the commencement of the charge.

The times of discharging and charging are less than those given for curves 10 and 11, partly because the P.D. was not allowed to run down lower than 1·9 volts per cell in the later observations, and partly because the times of discharging and charging had been diminished by the continued experimental rests to which these cells had been subjected in a charged state during 1889.

The mean temperature of one of our cells is during charging and discharging, roughly, 0·7° C. higher than that of the air; and experiment shows that if one of the cells experimented on be warmed up by a portion of the ordinary dilute sulphuric acid being replaced by warm sulphuric acid of the normal density, the cell will, after all parts of it have acquired a uniform temperature, fall in temperature by 0·2443° C. per hour. Of course, during such an experiment no current is allowed to pass through the cell, nor should any current have passed for hours before the heat emissivity of a cell is determined, otherwise a wrong value of the emissivity may be obtained by local action in the cell generating or absorbing heat during the experiment.

Hence, if K be the heat capacity of the cell, 0·7 × 0·2443 × K × 21½ calories (gramme, centigrade) will be lost by radiation and convection during the 21½ hours of charging and discharging. Now the weights and specific heats of the component parts of one of the cells under test are:—

	Weight in Grammes.	Specific Heat.
Dilute acid, sp. gr. 1·9 ...	10,490 ...	0·792
Lead and lead oxide... ...	12,987 ...	0·0315
Glass	3,402 ...	0·198

Hence, 0·2443 K equals 2,295 calories, and the loss of heat in charging and discharging equals 34,520 calories. The total watt-hours given to a cell in charging was 228·2 (see curve 11 for the *working* results obtained with the cells after the first rest of 10 days), therefore the energy in calories given to the cell was 0·24 × 228·2 × 3,600, or 197,200 calories. Hence, in consequence of the cell being slightly warmer than the air during charging and discharging, there is a loss of energy from radiation and convection equal to about 17 per cent. of the energy put into the cell, and this is more than sufficient to explain the total loss observed in the energy efficiency experiments, which amounts to only about 13 per cent. Indeed, it would almost seem as if a portion of this heat radiated must be supplied by an actual slow consumption of the material of the cell; so that, in addition to the reversible oxidation and deoxidation of the material, which is the characteristic of the secondary cell, there was a certain amount of non-reversible oxidation, which is the characteristic of the primary cell.

The loss of energy in consequence of the current having to overcome the resistance of the cell is of far less importance than the loss of energy due to the actual continuous radiation and convection from the cell, which is slightly warmer than the air. For the mean resistance during discharging of one of the cells experimented on may be taken as 0·004 ohm (see Section IX., Resistance, figs. 12 and 13), and the mean resistance in charging as 0·0045 ohm. Hence, during the normal 10 hours of discharge with 10 ampères there will be generated,

$$0{\cdot}24 \times 10^2 \times 0{\cdot}004 \times 10 \times 3{,}600, \text{ or } 3{,}456 \text{ calories},$$

and during the normal 11½ hours of charge with 9 ampères,

$$0{\cdot}24 \times 9^2 \times 0{\cdot}0045 \times 11\tfrac{1}{2} \times 3{,}600, \text{ or } 3{,}621 \text{ calories}.$$

Only, therefore, 3,456 calories need be dissipated during the discharge of a cell, and 3,621 during the charge, in consequence of the heat produced by the current overcoming resistance; and to dissipate this amount of heat it would only be necessary that the mean temperature of the cell should exceed that of the air by about $0{\cdot}14^\circ$ C., or only about one-fifth of the actual mean excess. Whereas what actually takes places is that during discharge about 16,060 calories are dissipated by radiation and convection; and, further, the cell cools down, possibly in consequence of the splitting up of the sulphuric acid, and from 6,000 calories in some experiments to 12,000 in others are thus absorbed. During the charge these 6,000 or 12,000 calories reappear warming up the cell, and, in addition, about 18,460 calories are dissipated by radiation and convention.

In order, then, to improve accumulators, what has to be especially sought for, and, if possible, then prevented, is that chemical action which keeps the mean temperature of the cell about 0·7° C. above that of the air. This chemical action is very possibly quite distinct from the reversible one which necessarily accompanies the storing up of the electric energy and its subsequent liberation.

IX.—RESISTANCE.

The resistance in ohms of an accumulator when charging and discharging is given respectively by

$$\frac{V - E}{A}, \text{ and } \frac{E - V}{A},$$

where V is the P.D. in volts at the terminals when a current of A ampères is passing, and E is the E.M.F. of the accumulator at the moment V is measured. To measure E the main circuit is broken, and the P.D. observed as quickly as possible. On breaking the circuit, however, the deflection of the voltmeter does not sharply change from the value that measured V to another definite value that measures E; but, on the contrary, as seen from fig. 4, in consequence of the fall of the E.M.F. of an accumulator on breaking the charging circuit, and in consequence of a similar rise in the E.M.F. on breaking the discharging circuit, the voltmeter deflection continues to vary for several minutes after the circuit is broken. Hence the value of E, measured by a voltmeter which is not infinitely dead-beat, must be too small during charging, and too large during discharging; and consequently, since the above formulæ for the resistance are only true when V and E are the *simultaneous* values of the P.D. at the terminals of the accumulator and of its E.M.F., it follows that the resistance has hitherto been measured too large both in charging and discharging.

The magnitude of the error that has been thus made in different experiments depends, of course, on how dead-beat a voltmeter was employed, and, consequently, on how long a time was allowed to elapse between the breaking of the main circuit and the taking of the reading. For example, we find that towards the end of the charge with the normal current of 9 ampères the E.M.F. varies about 1 per cent. in 20 seconds after the circuit is opened. Now, as the difference between V and E, which measures the resistance, is only of the order 0·1 volt when it has its maximum value during the normal charge or discharge—that is, of the order 4 per cent. of E—it follows that an error of 1 per cent. in the measurement of E would make an error of about 25 per cent. in the measurement of the resistance.

To measure the resistance accurately, we ought to be able to measure the difference between V and E to one-thousandth of a volt, and, therefore, as E is about 2 volts, the voltmeter must be very sensitive, with a long, open scale, and the needle must move through a considerable angle; whereas, in consequence of the rapid variation in E, the voltmeter must be very dead-beat—a condition almost incompatible with a long range and great sensibility.

(To be continued.)

THE TELEPHONE IN SWEDEN AND NORWAY.

In February of this year a report on the telephone and its extension at Stockholm and Gothenberg was presented to Parliament, and now another, referring to the telephone system at Christiania, has been printed. From this report we learn that the International Bell Company was the first, in 1880, to establish telephonic communication at Christiania. In 1881 a "Telephone Association" entered into competition with it, and obtained by the end of that year 224 subscribers, against 462 subscribers to the Bell Telephone Company. The two telephone systems continued to operate in competition with each other until the end of December, 1885, when the Bell Company had already fixed 995 apparatus, and the Telephone Association 634, representing an aggregate total of 1,629 subscribers. Their amalgamation into one company was at last effected by pressure on the part of the municipality, which prohibited the Bell Company and the Association from putting up any more wires separately.

On the 1st January, 1886, the Christiania Telephone Company superseded the two original companies, which were indemnified on the following terms, namely:—

Bell Company (its property was valued at £8,333)	£13,384
Telephone Association (valuation of property, £4,444)	7,000
Total	£20,384

The capital of the Christiania Telephone Company is 500,000 kroner (about £27,890), raised on 2,500 shares of 200 kroner (£11 2s. 3d.) each. The dividend declared for 1889 amounted to 5 per cent. on that capital, and the shares now stand at 25 per cent. premium. The number of subscribers on the 1st January, 1890, was 2,133, and their increase, expressed as a percentage, has been as follows:—

	Per cent.
1886	7
1887	17½
1888	33
1889	53½

The total number of apparatus under the control of the company at the end of 1889 was 2,405, of which 68 belonged to subscribers.

The following are the regulations under which telephones are established and worked in Norway:—

By a Royal decree issued in 1884, a law of July 31st, 1859, regulating the construction and maintenance of railways and telegraph lines in Norway was made applicable to the establishment of telephonic communication. In virtue of that decree permission has been granted to companies to establish telephonic communication either between towns and surrounding districts, or in rural districts between such districts, or with neighbouring towns, the licenses remaining severally in force for a period of five years. No exclusive right is given to individual companies, but no licenses are granted to competing companies before all the local authorities have been consulted. A royality is payable under a license only when the telephonic communication has been established between two or more places where telegraph stations are maintained by the State. The royalty annually payable is then calculated on a scale proportionate to the receipts from telegraphic correspondence between the points in question, and is generally fixed at one-half or one-third of such revenue. The licenses contain no conditions as to the purchase of the telephone exchange systems by the State, either within the periods for which they have been granted or on the expiration of non-prolongation of a license. The State allows telephone companies to place exchanges in connection with telegraph offices at their own cost, and without any responsibility on the part of the telegraph service for secrecy or accuracy of transmission. No charge is made to companies for such connection. A few companies have erected on their lines public telephone stations, to which telegrams can be sent from any telegraph office in the country. The companies are allowed to charge for the transmission of the telegrams sent by their lines a general rate of 0·50 kroner (6¾d.), regardless of the number of words. The tariff books of the State telegraphs specify this rate, and give the names of the telephone stations.

An exception, however, from this arrangement has been made in regard to the connection of a couple of places, where there had previously been State telegraph offices, with a private telephone in a neighbouring town. In these cases the State has given a subvention once for all, on condition that call offices should be provided, no extra charge made for telegrams, and a moderate tariff fixed for other use of the telephone from the points in question to the central office. The telephones established in certain rural districts by the State are regarded as part of the telegraph system, and are to some extent worked on telegraph lines that are utilised by the telegraph during only part of the year. In such places contracts are made for certain short periods of years with the interested parties, under a communal guarantee to the effect that an efficient clerk not connected with any mercantile business will be kept at the cost of such parties, and that the contractors will undertake the entire working of the telephone station, including free accommodation, lighting, heating, and the services of a messenger. They are granted a small subvention not exceeding 200 kroner (£11 2s. 3d.) per annum, and a small return of the charge for each conversation through the telephone is made to them. Telegrams are in such cases free of extra charges. In a couple of valleys, through the State telegraph lines run, telephone wires have been erected on the telegraph poles in order to connect road posting stations with the nearest telegraph office. These offices are all established on the principle just mentioned, except that the contracts remain in force for 10 years, and the contractors receive no subvention from the State, which has defrayed the cost of the lines and erection of the telephone stations, and which undertakes the repair of the lines and the keeping of the apparatus in order.

With regard to the description of telephone generally used, the gentleman sending the report to the Foreign Office (Mr. T. Mitchell) says it is the ordinary apparatus with magneto-electrical call bells. Relatively few apparatus of the electro-magnetic type, with which signals are given by battery current, are in use. The transmitters are generally on Blake's, and only a few on Ader's system. The receiver is either a Bell (one pole), or a Siemens (two pole) telephone. At the exchanges in Christiania and Bergen the central apparatus consist of multiple switchboards, but at all other places of switchboards of older construction. The apparatus are partly patented, and the State has no right to use or make them. The cost of a complete telephone, comprising one transmitter and one receiver, ranges, according to decorative finish, between 72 kroner (£4) for a magneto-electrical apparatus from the *Elektrisk Bureau* at Christiania, or from Ericsson at Stockholm, and 56 kroner (£3 2s. 3d.) for Bell Blake's apparatus, from the Bell Telephone Manufacturing Company at Antwerp. The average cost of maintaining in working order a complete telephone (transmitter, receiver and battery, or magneto-electrical call bells) is reckoned to be from 15 to 20 kroner (16s. 8d. to 22s. 3d.) per annum. The wires used for the State telephone lines are all of silicium bronze, of a gauge 2 mm. in diameter. Except at Christiania and Bergen, where silicium bronze wire 1·25 mm. in diameter is partly applied, the private companies use for the exchanges Swedish iron wire of 22 mm. in diameter. At Christiania aerial cables, containing 27 or 52 wires, are used in the vicinity of the central station. For inter-urban lines iron wire 3 mm. in diameter is used on short distances, and silicium bronze from 1·5 to 2·5 mm. in diameter on longer ones. The average cost per annum to the companies of maintaining 1 kilom. of wires is calculated to be from 10 kroner to 15 kroner (11s. 1½d. to 16s. 8d.). Private inter-urban wires are not allowed to be erected on the State telegraph poles. The State telephone wires are erected on the telegraph poles on the English system, which has been effective in preventing induction. The average cost of poles varies according to the place where the construction of lines takes place. The State pays for the best poles, 25 feet long, 6 inches in diameter at the top, with 3 to 4 inches heart, on an average 30 kroner (33s. 4d.) per dozen. The prices of poles supplied to the Christiania Telephone Company are as follows:—For pine 25 feet in length, 20 kroner (22s. 3d.); for fir, 22 kroner (24s. 6d.) per dozen; for pine, 50 feet in length, 70 kroner (77s. 9d.); for fir, 85 kroner (54s. 6d.) per dozen. The cost of wire is the ordinary market price. Silicium bronze wire, more especially, has been very fluctuating of late in price. The porcelain insulators for the State telephone lines (the type being the same as that used for telegraph lines) cost about 0·50 kroner (6¾d.) a piece. The cost of the double insulators used by the private companies is about 0·17 kroner (2d.) The cost of labour in the erection of the State telephone lines is the same as that for telegraph lines, and varies greatly according to the more or less mountainous ground to be passed. The average cost is about 80 kroner (88s. 11d.) per kilom. The private companies estimate the cost of labour at about 30 kroner (33s. 4d.) along the roads. On the houses it varies very much. The average may be said to be 25 kroner (27s. 9d.). It may here be remarked that the exchange and office work of the Christiania Telephone Company is principally performed by females. The annual charge for the use of a telephone in connection with an exchange varies greatly in the different companies: in the mutual societies, where the subscribers are owners of the lines, the apparatus, and the central station, the charge is from 30 kroner (33s. 4d.) to 60 kroner (66s. 8d.) per annum. When the companies are founded on shares, the annual charge is within the first circle (generally 1½ kiloms. from the central station) from 50 kroner (55s. 7d.) to 100 kroner (111s. 2d.), and is increased for greater distances. The Christiania Telephone Company, founded on shares, make an annual charge for the 1st circle of 80 kroner (£4 8s. 11d.), with an addition of 7·50 kroner (8s. 4d.) for each half kilom. beyond. The subscribers of telephone companies founded on shares are generally bound for one year. The mutual societies have not bound themselves to give any compensation for lines and apparatus belonging to former members. On the State telephone lines there is no special charge made for the telephoning of telegrams. For conversations by telephone the charge is 0·20 kroner (2¼d.) to 0·50 kroner (6¾d) for five minutes. Public call offices are provided only in a few towns. At Christiania they are generally established in the house of a subscriber (generally a shop), who receives a remuneration of 30 per cent. of the revenue, the charge for each conversation being 0·10 kroner (1¼d.), whether to subscribers or non-subscribers. All the telephone exchange wires are aerial and single. The existing trunk wires between towns (communications inter-urbaines) are all maintained by the companies, namely, between the following places:—Christiania-Gjövik, annual royalty to the State 300 kroner (£16 13s. 4d.),) distance about 110 kilom., charge for five minutes' conversation 0·50 kroner (6¾d.). Christiania-Hönefos, distance about 60 kilom., charge for five minutes' conversation 0·50 (6¾d.). Drammen-Kongsberg. Chris-

tiania-Moss, annual royalty to the State 2,000 kroner (£111 2s. 3d.), distance about 60 kilom.; charge for five minutes' conversation 0·50 kroner (6½d.) Skien-Porsgrund, royalty to the State 500 kroner (£27 15s. 7d.). Porsgrund-Langesund, royalty to the State 200 kroner (£11 2s. 3d.) The State has the right to erect poles and wires on public roads and private property against full compensation for value and damage under the provisions of the law of July 31st, 1859. Companies have no such legal right, but the local authorities and the landowners generally give permission to that effect without making any charge, the establishment of a telephone exchange being in the interest of the local inhabitants. The State telephone lines are regarded financially as part of the telegraph system, and the expense of their maintenance is expected to be covered by the revenue they yield. The total number of telephone exchanges (all private) in Norway is 30. The number of subscribers to each exchange, and the total number of inhabitants in each town or locality are shown in a statement hereunto annexed. The Government does not interfere in the establishment of private telephone systems to a greater extent than may be necessary in order to avoid collision between the different companies, and in order to protect the interests of the State telegraphs. In the latter respect the State only requires remuneration for a decrease in the number of telegrams exchanged between telegraph offices, contingent on the establishment of telephone lines between the same places. The system on which telephones are established and worked in Norway seems to be well adapted to a country of which the population is spread over a large extent of territory. The telephone exchange systems have, more especially in the two or three last years, grown rapidly—first, within the limits of certain towns or parishes, and then expanding to the surrounding districts or parishes. The telephone is being more and more regarded as a convenience of household necessity.

What bells are for calls inside a house, the telephone is for outside calls; and as there is no charge for royalties, &c., included in the cost of establishing an exchange, the subscription rate can be made so low that the acquisition of a telephone apparatus is within the reach of moderate means.

There are three appendices to the report, the third of which is as follows:—

The Number of Subscribers to each Telephone Exchange in Norway is:—

	Subscribers.	Inhabitants.
Christiania	2,133	140,000
Bygdö	35	Rural districts. The Christiania Telephone Company.
Strömsborg	7	
Sandviken	11	
Lilleströmmen ...	16	
Malmöen	9	
Dröbak	13	2,000
Hönefos	13	1,400
Bergen	750	50,000
Trondhjem	315	25,000
Drammen	145	20,000
Stavanger	148	24,000
Fredrikstad ...	142	12,000
Fredrikshald ...	97	11,000
Laurvik	90	11,000
Skien	94	7,000
Moss	70	7,000
Tromsö	63	6,000
Tönsberg	62	7,000
Christiansund ...	51	10,000
Christianssand ...	50	13,000
Arendal	50	4,000
Porsgrund	37	4,500
Langesund	?	Lately established.
Aalesund	37	7,000
Kragerö	28	5,000
Hammerfest ...	21	1,500
Sarpsborg	37	2,800
Haugesund	?	? Lately established.
Hamar	?	? " "
Horten	70	6,000 "
Bodö	?	? Lately established.
Kongsvinger... ...	57	?
Elverum	57	? Rural districts.
Slokmarknœs-Mebbo	7	...
Vormsund	23	Rural districts. The Nœs Telephone Company.
Ingeborrud ...	3	
Trögstad	11	
Nannestad... ...	5	
Eidsvold	27	Rural districts.
Vestre Toten Gran...	Lately established	The Oplandenes Telephone Company.
Ostre Toten Gjövik		

NEW PATENTS—1890.

10939. "Electric lamp holder and switch for capped incandescent lamps." C. McDONALD. Dated July 14.

10941. "Improvements in electrical contacts or collectors of electricity for railways and other purposes." F. WYNNE. Dated July 14.

11017. "Improvements in or relating to conduits and permanent way for electric railways." W. P. THOMPSON. (Communicated by J. Lynch, United States.) Dated July 15. (*Complete.*)

11042. "Improvements in electric thermometers and thermographs." J. W. GOOCH, C. A. BAKER and W. WHITE. Dated July 15.

11045. "Improvements in printing telegraphs." W.W. TAYLOR and E. M. LEAVENS. Dated July 15. (*Complete.*)

11052. "Improvements in telegraph receivers." C. LANGDON-DAVIES. Dated July 15.

11061. "Improvement in electric railway switches." H. H. LAKE. (Communicated by W. D. Swart, United States.) Dated July 15.

11065. "Improvements relating to the impregnation of organic, fibrous, and cellular matter, by means of an electric current, and apparatus therefor." G. A. ONCKEN. Dated July 15.

11070. "Improvements in and connected with electric measuring instruments, incandescent lamps, telephone transformers, electrically worked organs, and materials for jellygraph copying and printers' rollers." J. SWINBURNE. Dated July 16.

11130. "Improvements in insulating compositions for electrical purposes." A. N. FORD. Dated July 17.

11187. "Improvements relating to the manufacture of articles by electro-deposition, and to compositions for use in such manufacture." A. W. ARMSTRONG. Dated July 17.

11193. "Improvements in electrical switches." J. TRECZIOK. Dated July 17.

11240. "Improvements in electric arc lamps." J. Y. JOHNSON. (Communicated by L. Bardon, France.) Dated July 18. (*Complete.*)

11263. "Improvements in wall sockets for temporary electric connections." J. M. M. MUNRO. Dated July 19.

11272. "An improved ceiling rose for the suspension of electrical fittings." T. R. ANDREWS and T. PREECE. Dated July 19.

11312. "An improved device for maintaining electrical connection between separate railway trains." J. P. BAYLY. (Communicated by A. Baker, United States.) Dated July 19.

11319. "Improvements in apparatus to be used for electric welding." H. HOWARD. Dated July 19.

11327. "Improved electrically operated stamping and crushing machines." C. T. J. VAUTIN. Dated July 19.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1889.

4125. "Improvements in holders for incandescence electric lamps." W. O. ROOPER. Dated March 8. 8d. The holder consists of a cylindrical body made of vulcanite fibre, ebonite, china, or other suitable non-conducting material, to the outer surface of which are attached two or more spring clips which embrace the neck of the lamp bulb or globe, and two metallic attachments fitted with binding screws for connecting the leads to the lamp wires. The upper external part of the body of the holder is screw threaded to receive a screwed cap of brass or other suitable material, having a hole in the centre of the top thereof, through which the leads or conducting wires are passed on their way to the aforesaid metallic attachments. 5 claims.

5976. "An improved automatic electric alarm clock." A. LEYLAND. Dated April 8. 8d. Has for its object that of providing an electric alarm that will ring until stopped, and re-set itself ready for being operated, according to the time intended by the alarm dial. 4 claims.

6384. "Improvements in and relating to electric switches." A. A. GOLDSTON. Dated April 13. 8d. Claims:—1. In an electrical switch, the combination of a switch lever provided with two conducting pieces insulated from each other and adapted to be permanently connected to the main circuit, and two pairs of contacts, one of which pairs is designed to be connected with the terminals of the circuit to be introduced, while the other pair is in electrical connection, all arranged and operating substantially as described. 2. An electrical switch adapted to cause the main line current to pass through an "introduced" circuit or through a short circuit, the arrangement being such that when the current is passing through the short circuit the terminals of the "introduced" circuit will be out of electrical contact with the switch or with themselves, substantially as described. 3. The manufacture and use of the improved electrical switch described and illustrated in the drawing.

8157. "Improvements in switches for electric signalling apparatus." L. SELLNER. Dated May 16. 8d. Relates to switches by means of which any desired lamp from a number of white and coloured or continuously and intermittingly lighting electric incandescent lamps can be interposed into the circuit of an electric current generator, in order to give a signal, while, at the same time, an equal number of other lamps, provided for maintaining in the circuit unvariable resistance, are put out of circuit. 6 claims.

18638. "Improvements in the mode of driving electrical vehicles." A. Dickinson. Dated November 21. 6d. The gear is all mounted in an extra frame, one end of which is pivoted upon one of the bogie axles, and the other end is so mounted in a radial axle box or horn plates that this end of the frame is free to move upwards and downwards, but its liberty is governed by spring arranged to check its movement within certain defined limits. The central bearing of this moving end of the frame is circled so as to permit each of the two rail wheels to move unevenly without interference with the frame. The motor is mounted on a shaft near the centre, in suitable bearings, and transmits the motion through helical gear and counter shafts to the bogie axle on each side. 3 claims.

CORRESPONDENCE.

Electric Light Fittings.

With reference to your note of the electric light fittings at the Hotel Metropole, Brighton, we are much surprised that Messrs. Benham and Frowde should have informed you so incorrectly of the true facts of the case.

The electric light fittings at this hotel were supplied by at least four different firms, none of whom were responsible for the designs, which were supplied by Mr. Alfred Holland, one of the directors. Our firm supplied the fittings for the entrance and main halls, drawing rooms, library and reading room, smoking room, staircase, principal corridors, standards for 42 principal bed rooms, and fittings for all bath rooms and many offices.

It can hardly be said, therefore, that the electric light fittings have been supplied by Messrs. Benham and Frowde, and we are informed that the above form certainly the majority of them.

B. Verity & Sons.

July 26th, 1890.

Steno-Telegraphy.

In your paragraph on "steno-telegraphy," published in your number of July 18th, p. 71, you compare the latest form of Wheatstone's automatic instrument, such as now in use in England, and M. Cassagne's system. It is, nevertheless, a fact that this latter system—perfectly simple and reliable as it is—enables a single operator to punch his tape at a rate of speed not hitherto attained in telegraph work (100 orthographic words, or 200 shorthand, *i.e.*, phonetically spelt words, per minute).

This speed can be maintained for hours at a stretch. Moreover, the message is received in type.

This system is the only one, so far, which enables four persons, at the outside, to transmit 400 words per minute on a single wire. The difference between these four persons and the regular army of operators required for the same result with the Wheatstone system, is too important to be looked over by impartial minds.

The commercial aspect of the question can be summed up as follows :—

With two operators at each end of a line wire (four in all), M. Cassagne's instruments can send 400 words per minute. What would be the number of words sent by the Wheatstone in the same time, and with the same number of men ?

L. H. Despeissis.

3, Rue du Mont Thabor,
Paris, *July 28th*, 1890.

Brush v. King. Brown & Co.

This judgment does not in the least surprise me, but I must confess to being greatly amused with the idea of so much money being wasted in lawyer's fees.

I have come to the conclusion that there is scarcely one valid patent in existence. This is not merely a hastily formed and speculative opinion, but is based on a most careful study of the patent specifications ; a study to which I have devoted my spare time during the last six or seven years.

Nothing can be further from my thoughts than to insinuate that any of the existing patents have been obtained by those who were not *bonâ fide* inventors. Those patentees have doubtless acted in perfect good faith, and without the least desire to appropriate the lapsed or uncompleted patent of their predecessors. But the fact remains that very many inventions on which patents are now held without dispute, are anticipated, and set forth in former specifications with far clearer language than Mr. Varley used.

It is obvious that my remarks are to be taken in a broad and general sense. Every invention must necessarily be new at some time or other ; but it certainly seems very curious that many of the existing patents are to be found very exactly described in the specifications of twenty or more years back.

C. Purcell Taylor, D.Sc.

July 28th, 1890.

Secondary Battery Manipulation.

I have not the slightest doubt that Mr. Barber-Starkey's communication on the above subject, which appeared in a previous issue, will be read by many with interest, and, probably, by himself and others, may be considered new ; but this really is not the case, as the methods communicated by him are neither new nor novel, nor can they be considered any improvement in storage battery manufacture, according to present knowledge ; in fact, this ancient method, as suggested by Mr. Starkey, is rather a detriment to success than otherwise, as I well know from practical experience, having as far back as 1882 manufactured, in conjunction with Dr. Woodward, the inventor of the Woodward system, storage batteries in numerous shapes and forms, many of which I have still by me as historical productions, showing some of the early work carried out in connection with this section of the industry ; and, singular to say, amongst them is a cell in which the plates are divided by a compound packing of pulverised cocoanut fibre, boxwood, gypsum, &c., which was used by us as a separator of the lead plates. We also used many other forms of insulation, some of which were made from xylonite, Blake's embonita, vegetable ivory, and other fibrous materials suited for this purpose, which batteries, in various forms of manufacture, were publicly exhibited by my late firm at the "Engineering and Metal Trades Exhibition," held at the Agricultural Hall in the year 1883, and other exhibitions of more recent date ; and as a record of experimental research, I may say that in our experiments we found that pulverised cocoa-nut fibre was the best adapted for the purpose we then had in view, the manufacture of a compact form of spongy lead plate which could be closely packed side by side without fear of buckling or short-circuiting the cell when used for traction work ; but, after many experiments, this type of cell was abandoned by Dr. Woodward for his improved method, as now universally adopted by all makers of the Woodward cell, thousands of which are in daily use, doing good, active work in the United States of America, Canada, and other parts of the world ; and in all probability in the near future a like effect may follow in this country. I may also say that I explained Mr. Starkey's proposed plan to Mr. Joel, and many others in the trade, years ago ; and, if my memory serves me rightly, I believe patents were afterwards granted to Mr Joel and also to a Mr. Tatham, the former for the use of cocoa-nut fibre separator, and to the latter for the use of sawdust and cellulose packings in combination with lead or other alloys for storage batteries, and as neither of these batteries have ever come to the front as a success, I presume the inventors came to the same conclusion as myself, that there was no value in the supposed inventions, or we should have heard more about them.

The use of a little permanganate of potash, carbonate of soda, sulphate of soda in combination with mercury,

if well mixed with the acid solutions, or even compounded with the lead when in a molten state (although not a new idea), has undoubtedly certain advantages—it assists formation, besides making the plates more homogeneous when used in combination with the Woodward, Planté, or other type of spongy lead plates.

As a matter of history, I may say that the use of carbonate of soda is a very old idea, and was recommended by me some years ago, and is duly recorded in the *English Mechanic* notices, and anyone interested in this subject can, by referring to same, find the report.

Moreover, I may mention that I supplied Mr. J. S. Sellon with specimens of this class of spongy lead compound type plate as far back as 1885; also Mr. Crompton in the year 1887—both of whom can testify to the fact, should Mr. Barber-Starkey require further verification of the fact—consequently further comment upon this point from me is unnecessary.

I may say that sawdust and all fibrous packings and separators have a tendency to absorb and retain moisture, and owing to their porosity will occlude gases, which is an advantage; but this method of packing the plates does not and will not prevent evaporation, as Mr. Starkey supposes, and the reason why he found his cells in such a placid state was simply because they had been kept idle and at rest, for it is well known by all experts that the evaporation of the liquid never occurs to any great extent, except in cases where the cells are either overcharged or have been too rapidly discharged when in use. Evaporation will then occur, which is caused by the expansion of the ethereal energy stored up in the shape of minute molecules consisting of "a something," the component parts of which have yet to be determined by the aid of chemical science, which mysterious element may probably be a compound of etherealised ozone, or a species of azotic gas, most probably absorbed by the positive plate and held in combination with the oxide element contained in the cell. I have my own views upon the matter, but not being so well versed in chemical matters as I should like to be, I must leave the solution of this problem to our chemical *savants* to solve.

Arthur Shippey.

The Lineff Electric Traction System.

I read with considerable interest the careful and ably written report in your last issue by Mr. Kapp upon the new Lineff system of electric traction. The report itself is very fair and impartial—such as one might expect from the author—but I should certainly like to touch upon one or two points in this report, as well as the system described.

In the first place I feel pretty certain that, unless an absolutely rigid base support were given to the insulated rail sections, the inventor would speedily find them sinking down so much that they would be in contact at many points along the line with the internal conductor, and the galvanised iron strip would not be able to rise and make contact for the simple reason that it might be already wedged tightly between the conductor and the external rail, so making contact very effectually and permanently. Possibly I am doing the scheme an injustice from sheer ignorance, and when drawings appear this point may be shown to have had suitable attention. Nothing, however, will serve short of imbedding the insulated rail sections upon a good solid conduit, which also contains the conductor.

Even Mr. Kapp's apparently severe test of passing a heavy steam roller along the line does not altogether vouch for its efficiency; a single test like this does not compare practically with the ceaseless wear and tear of everyday traffic.

So long as a rigid connection is kept up between the conduit and insulated rail sections the device may be depended upon, but in proportion as this point is considered, so also are increased the difficulties of insulation.

Next, I must say that Mr. Kapp seems to have forgotten the old saying that refers to the weakest link of a chain; if any line has a minimum insulation resistance of 600 ohms and a maximum of 4,000, then the practical insulation resistance of that line ought, I think, to be looked upon as 600 ohms, and not as $\frac{600 + 4{,}000}{2}$.

An engineer is not altogether justified in reckoning on more than he can always and absolutely swear by; and as regards surface leakage, I fear this system (especially in our wet climate), would prove too wasteful for extended use.

Then, again, Mr. Kapp is, I think, a little unfair to the battery cars when speaking of the greatly increased weight to be carried.

From particulars of a large number of battery cars—all, indeed, that I could learn anything about—I found that the weight of the necessary cells complete was as nearly as possible that of the seated passengers at full load.

If the 20 passengers on the Lineff car weighed as much as the 3 or 4 tons that Mr. Kapp speaks of, then all I can say is, that they must have been in the prime of health and vigour—remarkably fine specimens, in short. A ton and a half of decently behaved cells ought to be ample for carrying 20 passengers along an average road.

One would wish very much for the sake of electric traction that one could see a prosperous future before such a system as that of Mr. Lineff: it is ingenious, it is novel (*pace* Mr. Holroyd Smith) and offers many advantages. But I fear the disadvantages would prove—in its present form—too serious to allow this method an extensive use. If practical service proves this feeling to be wrong, no one will be more pleased than

Frank B. Lea.

July 28th, 1890.

Secondary Batteries.

Referring to your article contained in your issue of the 25th inst. upon the merits of the Edinburgh paper upon "Storage Batteries," it would appear that when speaking of the relative ampère-hours between the E.P.S. 7L cells and the ampère-hours obtained by Prof. Ayrton and his assistants, you lost sight of the fact that five instead of seven plates were used in the latter's cells.

Passing on to your reference to the "author's" concluding remarks, you think that further study and research into the chemical actions, &c., of the present storage batteries might be the means of increasing their efficiency.

I would, however, remark, for the benefit of those interested, that in my opinion any further labour in the direction of your suggestion would be time and capital lost, unless (after taking all the defects of the present batteries into consideration) improvements to the extent of 100 per cent. were obtained, which would be necessary to hold its own.

Progress.

July 29th, 1890.

[In the experiments at the Central Institution "7L glass cells" were used, containing *five* plates, but our clerical error does not in the least affect the sense of the article. We did not state that "further study and research into the chemical actions, &c., might be the means of increasing their efficiency," but what we did say was that the promised "results on chemical investigations will be looked forward to with anxious interest by a large portion of the electrical fraternity," and we maintained that the efficiencies obtained by Prof. Ayrton and his colleagues were, in our opinion, too high, and should not be relied upon in practice. Our correspondent must have had very sad experience with secondary batteries, and we cannot agree with his views as to an abandonment of all further research in this direction.—EDS. ELEC. REV.]